REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
18-06-2008	Final Report	July 2007 - July 2008

4. TITLE AND SUBTITLE
Army Physical Therapy Productivity According to the Performance Based Adjustment Model

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Gregg, Scott, R, MAJ, SP

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Ancillary Health Division, US Army Medical Command
2050 Worth Road, Suite 10 ATTN: MCHO-CL-R
Ft Sam Houston, TX 78234-6010

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US Army Medical Department Center and School
BLDG 2841 MCCS-HFB (Army-Baylor Program in Health and Business Administration)
3151 Scott Road, Suite 1411
Fort Sam Houston, TX 78234-6135

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
31-08

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This study measures the variance in Army physical therapy (PT) clinic productivity as measured by the Performance Based Adjustment Model (PBAM) and identifies predictors of PBAM productivity in 34 Army PT clinics. The Military Health System Management and Analysis Reporting Tool (M2) and the Expense Assignment System (EAS IV) were queried to obtain FY 06 and 07 monthly encounter, relative value unit (RVU) and full time equivalent (FTE) data. Statistical process control identified extensive special cause variation in Army PT clinic productivity. Multiple linear regression analysis identified four predictors of PBAM productivity: 1) the proportion of work performed by technicians, 2) the proportion of FTEs recorded in non-patient care functional cost codes, 3) the number of RVUs coded per encounter and 4) the proportion of care that is outpatient-centered. The final prediction model obtained was R2 = .419 [F(816) = 146.00, p<.01]. Wide variation in Army PT clinic productivity exists partially as a result of varying technician staffing levels, manpower reporting practices, coding practices and inpatient workload.

15. SUBJECT TERMS
Army, physical therapy, PBAM, productivity

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	UU	88	Education Technician
					19b. TELEPHONE NUMBER *(Include area code)* (210) 221-6443

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Army-Baylor University Graduate Program in Health and Business Administration

Army Physical Therapy Productivity According to the Performance Based Adjustment Model

Presented to LTC M. Nicholas Coppola, Ph.D., FACHE

By
MAJ Scott Gregg
Baylor Admin Resident, MEDCOM HP&S

Ft Sam Houston, TX
2 May 2008

Abstract

Objective: This study measures the variance in Army physical therapy (PT) clinic productivity as measured by the Performance Based Adjustment Model (PBAM). In addition, the study identifies predictors of PBAM productivity in Army PT clinics. Methods: The Military Health System Management and Analysis Reporting Tool (M2) and the Expense Assignment System (EAS IV) were queried to obtain fiscal year 2006 and 2007 monthly encounter, relative value unit (RVU) and full time equivalent (FTE) data from 34 military treatment facilities (MTFs). Results: Statistical process control identified extensive special cause variation in Army PT clinic productivity. Of the 34 MTFs examined, 14 PT clinics demonstrated productivity above the upper control limit and 7 PT clinics (4 medical centers) had productivity below the lower control limit. Only 13 clinics had productivity within the range of common cause variation. Multiple linear regression analysis identified four predictors of PBAM productivity: 1) the proportion of work performed by the technicians, 2) the proportion of FTEs recorded in non-patient care functional cost codes, 3) the number of RVUs coded per encounter and 4) the proportion of care that is outpatient-centered. The final prediction model obtained for PBAM productivity was $R^2 = .419$ [$F(816) = 146.00$, $p<.01$]. Conclusion: Wide variation in Army PT clinic productivity exists partially as a result of varying technician staffing levels, manpower reporting practices, coding practices and inpatient workload. The PBAM productivity methodology appears to create a perception that medical centers (AMCs) are less productive than Army community hospitals and health clinics. Recommendations: Army PT clinics should adopt standardized best business practices to increase productivity and decrease variation. Establishing AMC and non-AMC peer groups in the future may yield more realistic and achievable PBAM productivity targets.

DISCLOSURE AS CALLED FOR BY ARMY REGULATION 360-1, THE ARMY PUBLIC AFFAIRS PROGRAM, EFFECTIVE DATE: 15 OCTOBER 2000.

"The assumptions, opinions, or assertions expressed in this publication are the private view of the author, and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government."

For clarification on any issues, interested parties may contact the author via e-mail at **scott.gregg@us.army.mil**

Table of Contents

Introduction

Conditions that Prompted the Study

TRICARE offers health care benefits to over 9 million beneficiaries at an annual cost of over $38.4 billion. Department of Defense (DoD) analysts project the cost of military health care to reach $64 billion in 2015, representing 12% of the projected Defense budget for that year (Coppola, Harrison, Kerr & Erckenbrack, 2007). The DoD has recently proposed combating rising healthcare costs by raising TRICARE fees and deductibles, but Congress has consistently barred TRICARE from raising these fees. At a House hearing in February of 2008, military advocacy organizations were asked about the issues they would like to see addressed in shaping the FY 2009 National Defense Authorization bill. Advocacy groups told the members of the House Armed Services Committee Military Personnel Subcommittee that they do not support TRICARE fee increases. Col. Steve Strobridge, USAF (ret.) , director of government relations for the Military Officers Association of America, stated that, "DoD seems a lot more interested in shifting costs to beneficiaries than they have, so far, in getting more efficient themselves" (Basu, 2008). With the backdrop of accelerating health care costs and unpopular DoD proposals to increase TRICARE fees, it is critical that the Military Health System (MHS) adopt strategies for improving efficiency and providing effective health care in a fiscally responsible manner.

The Army segment of the MHS monitors Military Treatment Facility (MTF) efficiency with specialty specific productivity benchmarks established by the Performance Based Adjustment Model (PBAM). Each MTF, regardless of size, enrollee demographics, and post mission, holds their respective clinics to the same externally developed PBAM benchmarks. This creates some consternation for many specialties, including physical therapy (PT), due to the perceived heterogeneity of clinics across Army MTFs. According to Paul Fogel (2000), author of

Achieving Superior Productivity, hospitals should avoid external benchmarking because such attempts usually end in failure. Comparing its productivity with that of other hospitals requires the hospital to conduct complex analyses aimed at equating different types of patients, distinct medical practices, conflicting traditions, and special tasks.

The fiscal year (FY) 2007 PBAM benchmark for PT clinic productivity was 17.32 Relative Value Units (RVUs) per privileged provider Full Time Equivalent (FTE) per day. This means that one therapist, and his or her support staff, should produce 17.32 RVUs during an 8-hour day devoted entirely to patient care. Applying this external benchmark to all Army PT clinics implies that all of these clinics have relatively homogenous characteristics that should result in similar productivity. According to the PBAM, when a product line, or grouping of similar services, fails as a group to meet the benchmark, that product line's facility may be decremented funds by the US Army Medical Command (MEDCOM). Conversely, a MTF may be rewarded additional funds for product lines that exceed the PBAM productivity benchmark (PBAM Handbook, 2007). Consequently, the PBAM gives MTF commanders incentivizes to maximize the productivity of their respective facilities.

Benchmarking should be goal directed and promote performance improvement by catalyzing pursuit of industry leading practices, creating objective performance measures, providing a customer focus, substantiating the need for improvement, and establishing data-driven processes (Ransom et al, 2005). Performance improvement will only occur if benchmarks are set at appropriate levels. If a proposed benchmark is perceived as impossible, it may do little to improve productivity and could also lower morale. On the other hand, if it is too low, it may not challenge the provider and productivity could suffer.

One way to identify the appropriateness of a productivity benchmark across a group of MTF clinics is to compare the individual clinic productivity measures. If clinics are indeed homogenous, one would expect little variation in productivity across the MTFs. Significant special cause variation due to fixed clinic characteristics indicates that the *one size fits all* benchmark may be inappropriate. Fixed characteristics could include facility mission or mission-driven staffing ratios. Special cause variation due to potentially modifiable characteristics should be the focus of process intervention. Modifiable characteristics could include general business operations or inconsistencies in workload coding and manpower reporting.

The objective of this study is twofold. First, statistical process control (SPC) will be used to identify the potential presence of special cause variation in the unit of analysis, Army PT clinic monthly productivity. Next, a regression analysis will be conducted to definitively assign some portion of the variation to fixed or modifiable PT clinic characteristics. Independent variables that will be examined are: 1) the proportion of total clinic workload performed by technicians, 2) the proportion of available work hours recorded outside of patient care, 3) the number of RVUs coded per encounter and 4) the proportion of RVUs related to outpatient care. Variation due to fixed clinic characteristics such as the proportion of outpatient care would suggest the need for productivity peer groups. Any variation due to modifiable characteristics such as the number of RVUs coded per encounter would suggest the need for examination of local business practices in clinics identified as highly productive or not productive. The conclusion of this study will recommend immediate strategies for optimizing PT clinic productivity and future strategies for conducting additional research.

Statement of the Problem or Question

The PBAM does not generate MTF-specific clinic productivity benchmarks. With MTF funding directly tied to productivity, it is crucial that individual MTF clinics, such as PT, are held to a meaningful and appropriate benchmark that is based on specific clinic characteristics. Hence, the significance of the primary research questions: 1) Are productivity differences across Army PT clinics due to special cause variation? and 2) How do we measure the productivity of Army PT clinics with regression analysis? Additional questions to be considered include: What are the fixed and modifiable causes of special cause variation in productivity among Army PT clinics? Can the causes of special variation be used to place clinics into peer groups? What strategies should be adopted for decreasing modifiable variability across Army PT clinics? Finally, what additional research should be conducted to further the understanding of PBAM productivity within PT and other health care clinics?

Literature Review

The Military Health System

The MHS mission is to provide health services to all eligible beneficiaries while simultaneously maintaining the medical combat readiness of the Army, Navy, Air Force, Coast Guard, and commissioned corps of the Public Health Service. Through a unique form of managed care known as TRICARE, the MHS provides direct care through more than 70 Military Hospitals/Medical Centers, 411 Medical Clinics, 417 Dental Clinics and over 100 region-specific first aid stations located worldwide (Coppola et al., 2007). The Army operates more than 80 PT clinics associated with 36 MTFs located across 6 Regional Medical Commands (RMCs). When MHS facilities are unable to meet the demand for medical services, TRICARE supplements the military capability with network and non-network health care professionals. This health care provided by non-military facilities is referred to as *purchased care*. The existence of purchased care supports the need for productivity benchmarks as an incentive to maximize direct MTF care and therefore minimize purchased network care.

TRICARE offers benefits to approximately 1.7 million active duty service members and 7.5 million dependents and retirees at an annual cost of over $38.4 billion, making it the largest single provider of managed care in the United States (Coppola et al., 2007). The TRICARE program is available to all uniformed service members, retired military, and their families worldwide. Family members include spouses, unmarried children under age 21, and unmarried children under age 23 enrolled as full-time students.

TRICARE's existence is threatened by the cost of its program. Department of Defense analysts project the cost of military health care to reach $64 billion in 2015, which represents 12% of the projected Defense budget for that year (Coppola et al., 2007). Hence, Congress closely monitors military health care budgets and major health care expenditures. To control costs, the MHS has adopted a Prospective Payment System (PPS).

Productivity is crucial in the MHS's current prospective payment system. Prior to FY 2005, productivity did not have a direct impact on MTF funding. Starting in FY 2005, however, funds were allocated to MTFs based on a blend of 75% traditional budget (based on number of enrolled beneficiaries) and 25% PPS budget. The PPS budget proportion has been increasing by 25% each year since 2005. Therefore, during FY 2008, the budget will be based entirely on prospective payments (Opsut, 2007). Under this new PPS, MTFs that do not meet productivity benchmarks may be decremented funds by the PBAM, hence the increasing emphasis on productivity.

Productivity

Productivity is defined as the number of output units per unit of input (Ozcan, 2005). In the outpatient health care setting, inputs are typically aggregated as FTEs or hours worked, and outputs are aggregated as visits or relative workload. MTFs measure outpatient provider productivity as the ratio of the relative work value of the patient care completed (measured in RVUs) to the hours spent actively providing patient care (measured in FTEs). Working hours are recorded using the Uniform Chart of Accounts Personnel Utilization System (UCAPERS) or the new Defense Medical Human Resource Data System internet (DMHRSi), and workload is tracked using the Ambulatory Data Module (ADM). UCAPERS collects and reports medical labor and expense data required for the Medical Expense and Performance Reporting System (MEPRS). ADM collects and reports patient diagnoses and procedures, enabling providers to track and manage the care provided to their patients (MHS Help Desk, 2007).

Productivity within Army health care clinics is calculated as the RVUs per privileged provider per day. In PT clinics, only the physical therapists are privileged providers, so any RVUs generated by physical therapy assistants or technicians are aggregated under the total clinic workload. Physical therapy providers do not generate workload based on recording evaluation and management (E & M) codes in ADM. Physical therapy providers only receive RVUs based on documented procedures recorded in ADM as common procedure terminology (CPT) codes. For example, a physical therapy evaluation generates 1.2 RVUs and a 15-minute ultrasound treatment generates .21 RVUs of workload. See Appendix A for a list of commonly used physical therapy CPT codes and their associated work RVU value. Recent PT productivity is negatively affected by limitations of the current Standard Ambulatory Data Record (SADR) in ADM. The SADR is unable to recognize more than four procedures per encounter or multiple units of the same procedure during an encounter. For example, documenting and coding for three units of individual exercise will only credit the provider with one unit. This limitation should be corrected with the implementation of the Comprehensive Ambulatory/Professional Encounter Record (CAPER) during FY 2008 (R.L. James, personal communication, April 16, 2008). The CAPER will capture multiple units of treatment and up to ten different procedures per encounter.

Performance Based Adjustment Model

Army health care productivity benchmarks are mandated by the PBAM. The PBAM accounts for provider availability, proper coding of medical records and use of CPGs (Clinical Practice Guidelines) to adjust hospital and clinic funding levels to reflect the cost of actual health care delivered (PBAM Handbook, 2007). Facilities that exceed productivity goals are rewarded with additional funding, and facilities that fail to meet productivity or population health goals may be decremented funds. Funding adjustments are based in part on meeting product line goals. A product line is a group of clinics that provide a similar or related service. Physical therapy is part of the orthopedic product line which typically also includes orthopedics, podiatry, chiropractic services and occupational therapy. An unrealistically high PT productivity benchmark could cause the orthopedic product line to miss its productivity target resulting in the decrement of MTF funds. Conversely, a low benchmark may not create incentives to optimize clinic efficiency and productivity.

The Evidence Based Practice section of the model is based on the Health Effectiveness Data and Information Set (HEDIS), a group of performance measures that is sponsored, supported and maintained by the National Committee for Quality Assurance. These measures assess the ability of managed care organizations to prevent complications for enrollees by delivering preventive care and managing chronic and acute illness (PBAM Handbook, 2007).

Because HEDIS measures do not focus on musculoskeletal issues, PT clinics are concerned primarily with the productivity section of the PBAM. The productivity benchmarks for most specialties are derived from civilian productivity levels for ambulatory visits based on the Medical Group Management Association (MGMA) academic RVU / Provider / Day standards. Military providers are generally held to an 85% MGMA standard. This lower standard accounts for data entry inefficiencies due to the Armed Forces Health Longitudinal Technology Application (AHLTA) and the Composite Health Care System (CHCS), the military health care mission to "project a Healthy Force" (not profit motivated), the need to continuously train staff due to the constant flow of personnel and other considerations. Specialty clinics without a respective civilian MGMA standard are held to a benchmark based on historical workload (PBAM Handbook, 2007).

Because the MGMA standard for PT productivity (10.59 for CY05; 11.52 for CY07) does not include technician workload, the military PT benchmark is based on FY05 aggregate historical productivity (17.32 RVUs / Privileged provider FTE / Day). Aggregate historical workload is calculated by dividing the aggregate RVUs (produced across all Army PT clinics) by the aggregate physical therapist FTEs (across all Army PT clinics). It is important to note that the productivity calculation includes the RVU *workload* of technicians but does not include the *FTEs* of technicians. Consequently, a robust technician staff could inflate the perceived productivity of an individual clinic. The PBAM benchmark is reevaluated and adjusted annually by the MEDCOM Health Policy and Services Division (HP&S). The new benchmarks are briefed to the Office of the Surgeon General (OTSG) prior to final implementation. The FY08 benchmark for PT productivity will be slightly decreased to 17.10 RVUs / FTE / Day based on the recent RVU value adjustment by the Center for Medicare and Medicaid Services (CMS).

Relative Value Units

RVUs are nonmonetary relative value units of measure assigned to medical CPT codes copyrighted by the American Medical Association (AMA) (Glass, 2002a). These units assign relative values or weights to medical procedures primarily for the purpose of reimbursement for services performed, but they are also used for productivity measurements, cost analysis and benchmarking (Glass).

The idea of a Resource-based Relative Value Scale (RBRVS) was developed in the 1980s as a direct result of rapidly increasing Medicare spending, inequitable reimbursement for procedural services over cognitive clinical services, and the influence of income on career choices of medical graduates (Hsiao, 1987). In 1986, Congress' Physician Payment Review Commission mandated the creation of a new resource-based physician fee schedule with the objective of improving primary care reimbursement and controlling health care costs (Johnson & Warren, 2002). This spurred the 1988 study by William C. Hsiao from the Harvard School of Public Health. Hsiao's research examined the resources and costs required to provide physician services in order to create a relative value scale that would set reimbursement more fairly than the previously used system of *usual and customary fees*. Hsiao studied 18 medical specialties in order to develop appropriate procedure-specific RVU values. He also developed methods that estimated the relative values of unselected services, such as physical therapy, by extrapolating from values obtained for selected services. The RBRVS was officially adopted by CMS in 1992.

RVU values were initially established by the Hsiao study. Annual updates to the work relative values are based on recommendations from a committee involving the AMA and national medical specialties (AMA, 2006). These updates have a direct effect on the setting of PBAM productivity benchmarks during the annual review by MEDCOM HP&S.

Total RVUs are split into three components: work, practice expense, and malpractice. The work component measures a provider's involvement in performing a procedure by aggregating procedure complexity, intensity and the degree of independent judgment and decision making skill required. The practice expense component measures the amount of direct and indirect medical support for performing a procedure. The malpractice component measures the degree of risk for performing a procedure. The MHS does not consider the malpractice component because provider malpractice is covered under the Federal Tort Claims Act. On average, the RVU work component accounts for approximately 54% of the total RVUs for a medical procedure while the practice expense and malpractice components account for approximately 41% and 5% respectively (Glass & Anderson, 2002a).

RVUs allow practice administrators to objectively measure provider productivity and performance data versus traditional productivity measures such as encounters or net charges. The work RVU, in particular, allows comparison of provider productivity within and between specialties. It is imperative, however, that coding is performed correctly. If medical services and procedures are inaccurately or inappropriately coded, then an RVU analysis will reflect skewed data and result in poor management decisions. For calculating productivity in the MHS, only work RVUs are considered. RVU data is available in the Military Health System Management and Analysis Reporting Tool (M2) database.

Full Time Equivalents

An FTE is defined as the amount of labor available to the MTF work center if a person works for one month. Therefore, one FTE is equivalent to 168 man hours (21 days/month x 8 hours/day). When calculating productivity, only hours recorded as available in the ambulatory cost center are considered as productive hours. Nonavailable hours (leave, loaned elsewhere, sick) and hours outside the ambulatory cost center are not considered in the PBAM productivity calculation.

Functional cost codes (FCC) are 4-letter MTF specific codes that represent work centers and are used to track costs, workload and FTEs. The first letter identifies the type of service provided:

A – Inpatient Care
B – Ambulatory Care
C – Dental Care
D – Ancillary Services
E – Support Services
F – Special Programs
G – Medical Readiness

The second letter identifies summary accounts within MTF functional categories. The third letter identifies particular work centers within summary accounts. Finally, the fourth letter is MTF-unique and used to identify specific location or type of costs and workload. The 3-letter FCC for physical therapy is BLA across all MTFs. The fourth letter is generally an 'A' but may vary if a post provides physical therapy in multiple locations. For example, the Brooke Army Medical Center ambulatory PT clinic is BLAA, the Institute for Surgical Research is BLAI, and the Center for the Intrepid is BLAG. It is important to note that, despite the existence of inpatient FCCs, *all inpatient PT workload and manpower is recorded under the outpatient BLA FCC.*

UCAPERS and DMHRSi track FTEs based on five different provider types:

I – Clinicians (Physicians or Physicians in training)
II – Direct Care Professionals (Physician Assistants, Physical Therapists, etc)
III – Registered Nurses
IV – Direct Care Paraprofessionals (Licensed Practical Nurse, LVN, PT Technicians, etc)
V – Administrator, Clerical, Logistics

Only type I and II provider FTEs are considered when calculating PBAM productivity. Hence, physical therapy technicians, as type IV providers, do not contribute their FTEs to the productivity calculation. FTE data is available in the Expense Assignment System (EAS IV) database (MADI Workshop, 2007).

Benchmarking

The purpose of benchmarking is to identify and match the best health care processes (Ozcan, 2005). Hence, benchmarking typically compares an organization's performance to that of an industry leader or exemplary-performing organization. Alternatively, an organization may instead use historical benchmarking as a way of monitoring its own performance over the past few years. Historical benchmarking, however, does not necessarily focus on best processes, and may not promote performance improvement.

Benchmarking should be goal directed and promote performance improvement by catalyzing pursuit of industry leading practices, creating objective performance measures, providing a customer focus, substantiating the need for improvement, and establishing data-driven processes (Ransom, Maulik & Nash, 2005). Comparisons can be made internally within or among specialties in one facility or externally against peer groups or "better-performing" practices (Glass & Piland, 2002d). Internal benchmarking is much easier because internal goals and objectives are unique for each organization and depend in part upon the mission, strategic plan, market, culture, community and other variables.

Because RVUs are nationally standardized, they provide the best measurement tool that is both statistically valid and reliable, making them the best available measurement in today's health care benchmarking arena (Glass & Piland, 2002d). This is why the MHS uses the RVU for establishing productivity standards. The FY 2007 PT PBAM productivity target of 17.32 RVUs is a historical benchmark derived from aggregating total RVUs and total FTEs from FY 2005 across all Army PT clinics. This external productivity benchmark is applied to all Army PT clinics regardless of size, staffing mix, or inpatient mission. Additionally, because the benchmark is historically based, it does not necessarily encourage improvement towards the productivity level of an exemplary-performing organization.

Civilian PT Productivity Expectations

The American Physical Therapy Association (APTA) does not have guidelines for determining appropriate productivity standards. According to the APTA, "productivity standards are generally determined by facilities, based on the specifics of their population, staffing mix, etc." (APTA, 2007). Hence, the PBAM benchmarking methodology is at odds with the APTA's view of how to establish productivity standards. Despite the lack of APTA productivity guidance, the Association does report productivity expectations of physical therapists derived from Practice Profile Surveys.

In the APTA's most recent Practice Profile Survey conducted in 2005, 57.9% of respondents reported a productivity standard required by their facility. Standards established in the private outpatient segment were generally more stringent than those established in any other practice settings. Based on this civilian trend, one might speculate that large MTF PT clinics with a substantial inpatient mission may have lower productivity than MTFs with a purely outpatient physical therapy mission.

Although the Practice Profile Survey does not report a *RVU / FTE / Day* metric, it does provide a *visits per week* metric. The reported *mean expected visits per week* varied considerably by practice setting as seen in Table 1. Comparing the productivity data in Table 1 demonstrates that Army clinics in 2007 performed above the expected productivity levels of civilian clinics in 2005. However, the Army productivity value is inflated because it only considers time actually spent performing patient care. For example, if an Army PT spent 80% of a 40-hour week performing patient care, that PT would generate 58.8 x 80% or approximately 47 visits that week. Regardless, Army PT clinics appear to be demonstrating productivity that is very similar to the expectations of civilian PT clinics.

TABLE 1

Expected Civilian Productivity for Annual Year 2005 vs. Actual Army Productivity in FY 2007

Facility	Number of Visits per Week
Civilian Acute Care Hospital	33.3
Civilian Health System / Hospital Based Outpatient Facility	41.8
Civilian Private Outpatient Office / Group Practice	54.5
Army MTF Actual for FY 2007*	58.8

Note. Civilian facility data from 2005 APTA Practice Profile Survey. Army productivity calculated from data queried from M2.
* (484,920 therapist encounters / 1964 available therapist FTEs / 21 days) x (5 days / week)

Other Military Medical Specialty Productivity Studies

A 2003 Military Medicine article describes the development of meaningful metrics of clinical productivity for MTF anesthesiology departments (Mongan, Van Der Schuur, Damiano & Via). The study applies several productivity metrics to four different MTFs and notes the reasons for variability among the four facilities. Mongan et al. note that the productivity benchmarking process is often difficult when comparing the operative service productivity of large and small MTFs due to the significant heterogeneity in mission focus and case complexity. These heterogeneity issues are also possible in other specialties such as physical therapy.

In another Military Medicine article, the authors suggest a productivity benchmark for optometric services (Archila, Jarecke, Damiani & Boorady, 2007). The study uses M2 aggregate data to determine the mean number of RVUs generated per optometry patient encounter across the Army, Air Force, and Navy. The tri-service overall mean of 1.45 RVUs per patient was multiplied by the expected number of patient visits per day from the American Optometric Association to arrive at a benchmark recommendation of 18.85 RVUs per day. This benchmark would assume that 100% of the optometrist's time is available for patient care during a particular day. The article does not mention the issue of heterogeneity of optometry clinics when developing a tri-service benchmark. This would suggest that, when compared to physical therapy clinics, optometry clinics are not concerned with significant variability in mission or case mix across MTFs. In addition, optometry techs do not generate as much RVU workload as physical therapy techs. Although an aggregate benchmark may be appropriate for a specialty such as optometry, the apparent heterogeneity of PT clinics suggests the possible need for a peer group benchmark.

Structural Contingency Theory

Applying SPC to the 34 Army PT clinics in this study will determine if special cause variation exists between clinics. Based on structural contingency theory and the varying environmental contexts of each clinic, one would expect the existence of substantial variation. Each clinic has responded over time to varying environmental stimuli, such as hospital size, mission, culture and case mix, by adapting to achieve a better fit within the particular MTF.

Structural contingency theory may be summarized as the *It depends theory*. This particular theory seeks to explain why so many organizations are different. Organizational success is based on the ability to adapt to a mixture of internal and external factors in order to achieve a *good fit* and survive. The underlying assumptions of contingency theory are: organizational structures are open and are not organizationally egalitarian; there is no one best way to organize an organization; and any one way of organizing is not equally effective in another organization (Coppola, 2003). Therefore, one would expect PT clinics to display heterogeneous characteristics based on their desire to achieve a good fit with various environmental factors.

The current PBAM productivity benchmark considers only the single environmental factor of labor, defined as type I and II FTEs. Therefore, it is conceivable that this benchmark does not offer the most accurate measure of productivity as a means of determining organizational performance. See Figure 1.

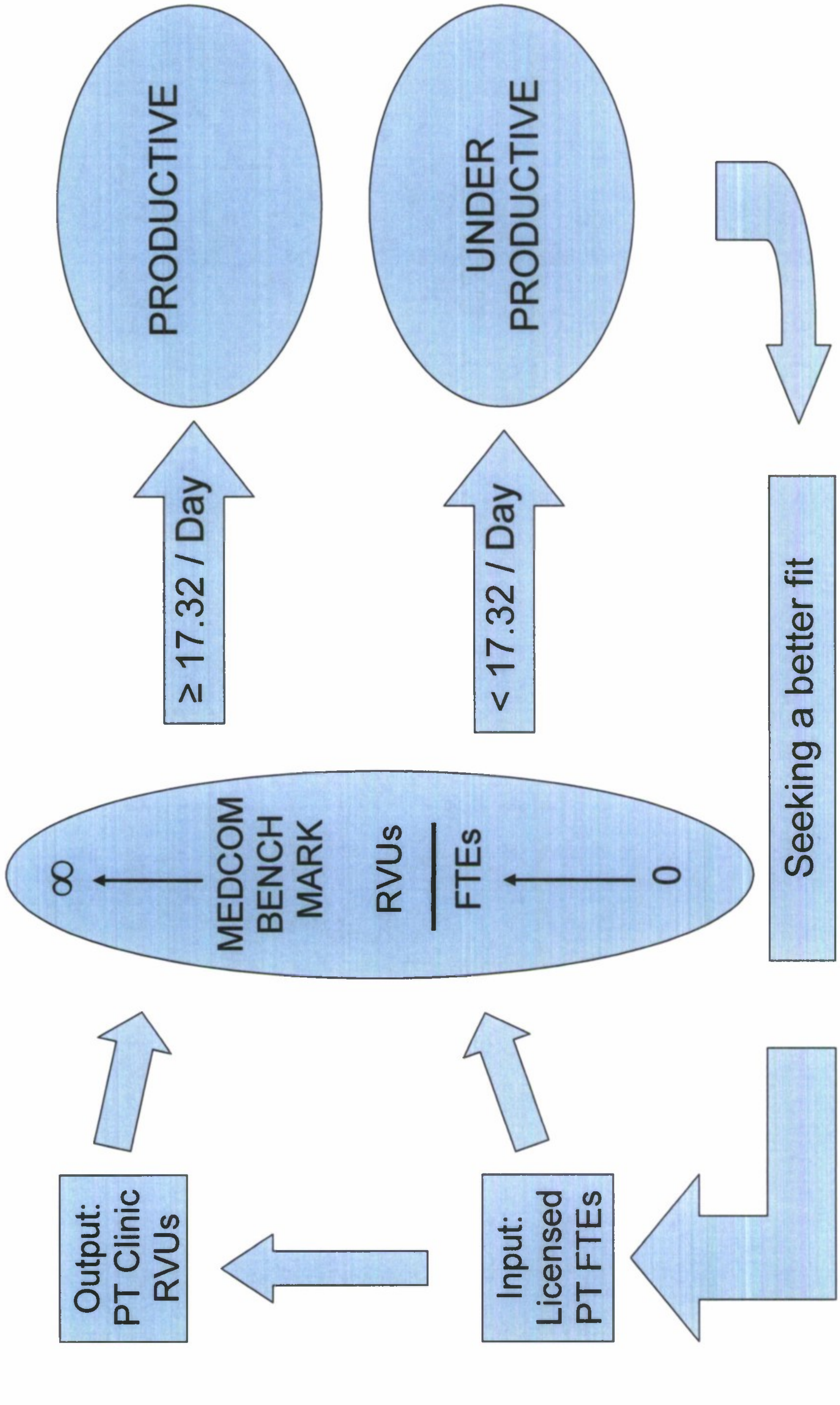


Figure 1. Conceptual model of the current PT PBAM productivity benchmark

PT clinic productivity is derived from licensed physical therapist FTEs and total clinic RVUs. Those clinics that surpass the 17.32 RVUs / FTE / day are considered productive. Clinics that do not meet the benchmark are considered unproductive and must seek a better fit with the environment to increase productivity. This model, however, fails to account for additional relevant environmental factors. Further discussion is necessary to arrive at a potential future model for applying a benchmark to PT productivity.

According to contingency theory, performance is a consequence of the fit between several factors: structure, people, technology, strategy, and culture (Tosi & Slocum, 1984). Tosi and Slocum go on to state that efficiency within the contingency theory framework can be measured according to how organizational resources are arranged, and the amount of resources used to produce a unit of output. Therefore, a better benchmark may consider environmental factors such as organizational structure and culture of a particular MTF.

Donaldson's Structural Adaptation to Regain FIT (SARFIT)

A derivative of contingency theory is the SARFIT model. Donaldson (2001) supports the contingency theory supposition suggesting that there is no one best way to organize an organization. Building on that supposition, Donaldson suggests that regardless of the institution's organizational methodology, the goal is to organize itself as efficiently as possible to achieve high performance. When the organization fails to achieve high performance, Donaldson suggests that the organization then undergoes a reevaluation of its internal production processes.

Coppola (2003) developed a conceptual model of Department of Defense MTF efficiency utilizing the SARFIT derivative of contingency theory. Minor modifications to Coppola's model yield an alternative conceptual model (See Figure 2) for establishing an alternative PT productivity benchmark at the level of the individual clinic or clinic peer group. This alternative model considers culture (Army only for this study), structural inputs, and environmental inputs. Clinics meeting the input-based benchmark are considered efficient. Clinics not meeting the input-based benchmark are considered inefficient and must reevaluate their inputs in order to regain fit and increase efficiency.

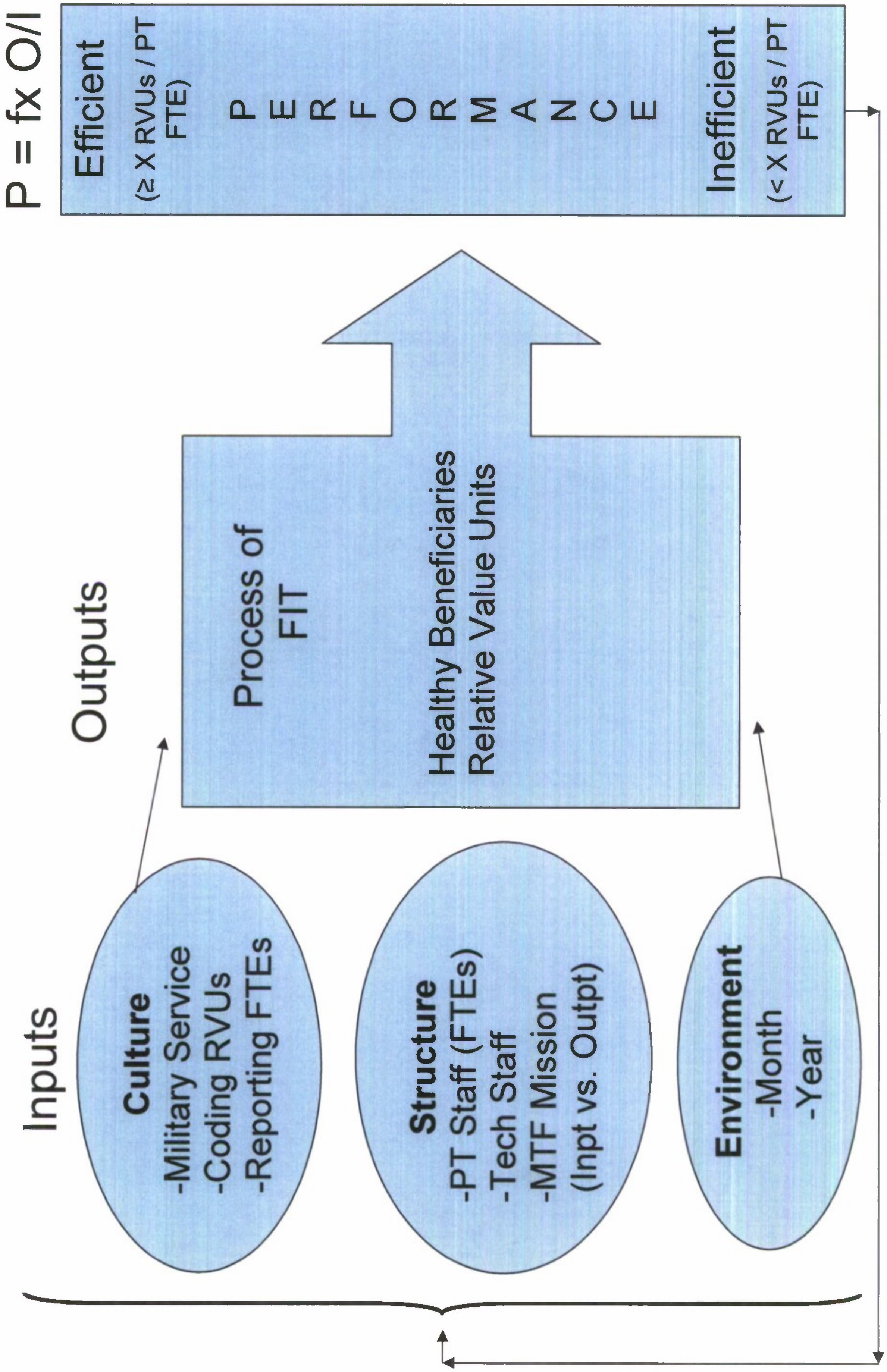


Figure 2. Proposed conceptual model for establishing productivity benchmark
Adapted from Coppola's Conceptual Model of Department of Defense MTF Efficiency (2003)

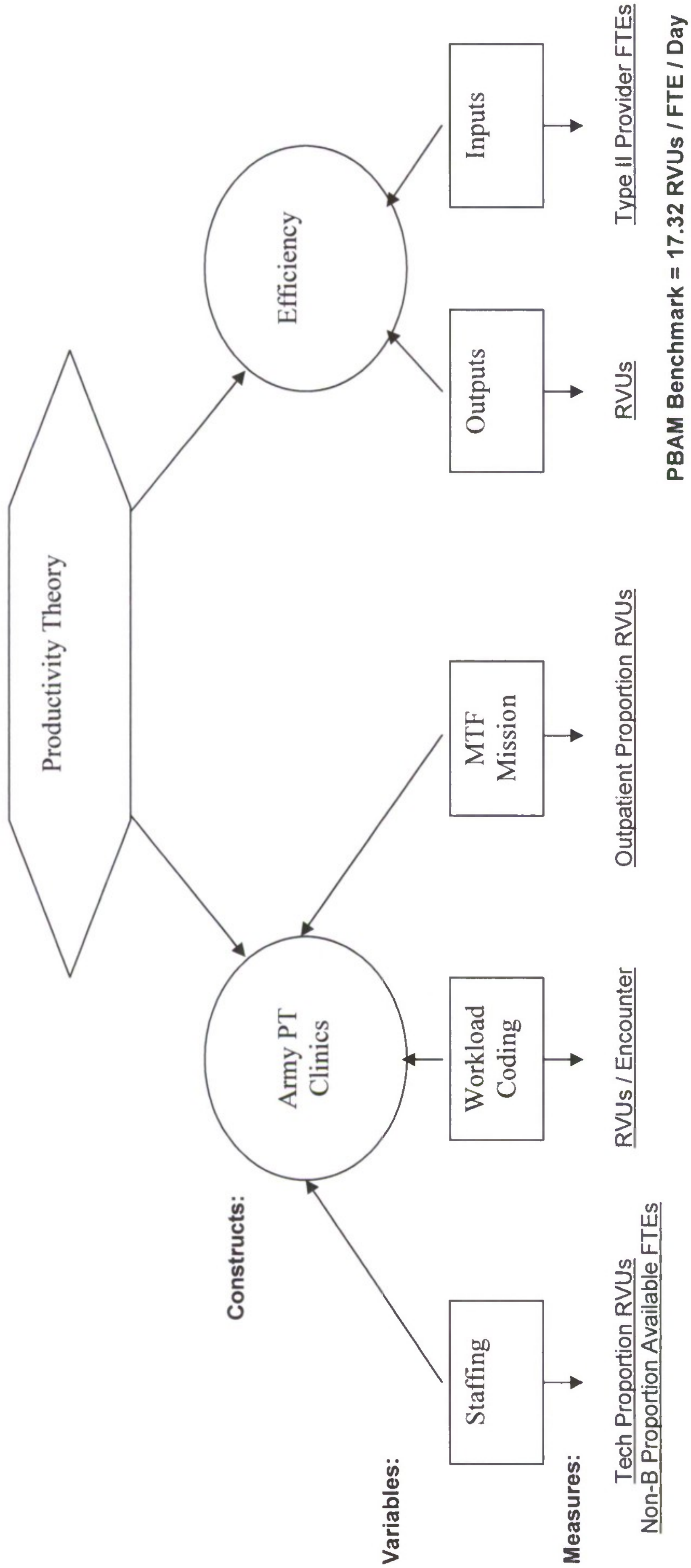


Figure 3. Conceptual model of Army PT clinic productivity

Constructs, Variables, and Measures

According to Bacharach, constructs are approximated units or terms, though not observable either directly or indirectly, that may be defined based on observables (1989). Based on the proposiotion that *Army PT clinics are efficient,* this particular study has two constructs: *Army PT clinics* and *efficiency*. Variables, derived from constructs, are observable and capable of assuming two or more values. Army PT clinics are defined using three variables and efficiency is defined using two variables. Finally, the individual variables are operationalized by applying measures, discrete values that can be expressed numerically. See Figure 3.

Efficiency refers to how well resources are allocated to achieve a given result. Optimal efficiency occurs when production and distribution cannot be reorganized to increase the utility of one or more units without decreasing the utility of other units. Efficiency in health care is considered crucial to quality because inefficient care uses more resources than necessary and is therefore of lower quality (Ransom et al, 2005). "Wasteful care is either directly harmful to health or is harmful by displacing more useful care" (Donabedian, 1988).

Efficiency, which is generally synonymous with productivity, can be expressed as a ratio of outputs to inputs. Applying the PBAM methodology, outputs are defined as clinic work performed (RVUs) and inputs are defined as manpower expended (Type I or II provider FTEs). Outputs account for all RVUs performed in the outpatient or inpatient setting recorded under the physical therapy FCC, BLA. Inputs account for all licensed physical therapist available FTEs recorded under the same physical therapy FCC. It is important to note that technician (type IV provider) FTEs are not considered as an input in the PBAM methodology. The PT PBAM productivity benchmark established by MEDCOM and OTSG for FY2007 was 17.32 RVUs per type II provider FTE per day.

Army PT clinics have varying staffing ratios, coding practices, and missions. PT to technician staffing ratios vary widely across clinics ranging from a nearly 1:1 ratio in large Army Medical Centers (AMCs) to a 2:1 ratio in smaller Army Community Hospitals (ACHs) and Army Health Clinics (AHCs). Because the PBAM productivity model does not consider technician FTEs, staffing variations can have a profound effect on the PBAM productivity measure. However, the mere presence of technician FTEs does not guarantee that these techs are generating RVUs. Therefore, to determine the effect on clinic *PBAM* productivity, technician staffing was operationalized as the proportion of RVU workload performed by the type IV provider staff each month.

Only therapist FTEs recorded in the BLA FCC are considered as inputs in the PBAM productivity methodology. However, clinicians are encouraged to record time in non-B cost centers when performing non patient-care activities such as administration (EBD), clinical instruction (FAK), or local readiness training (GCA). Therefore, one could hypothesize that clinics accurately accounting for non patient care time will appear more productive than their counterparts. To determine the effect on clinic PBAM productivity, therapist staffing was operationalized as the proportion of available FTEs recorded in non-B FCCs each month. Therapist staffing was operationalized as non-B time as opposed to B time in order to establish a positive correlation.

Workload coding refers to reporting the procedures and their respective RVU values associated with each clinical encounter. Clinics that actively focus on optimizing coding would likely experience higher productivity. Therefore, to determine the effect on PBAM productivity, coding was operationalized as the average number of RVUs generated per encounter each month.

MTF mission is the final variable considered under the construct of Army PT clinics. MTFs have varying missions based on beneficiary demographics, geographic location, post mission, and the presence of graduate medical education programs. Large hospitals such as Walter Reed and Brooke AMCs serve robust inpatient and Warrior Transition Unit populations. Anecdotally, PT clinics consider the provision of inpatient rehabilitation as a decrement to average clinic productivity. Therefore, to establish a positive relationship to productivity, MTF mission was operationalized as the proportion of total RVUs recorded each month in the outpatient setting. See Figure 4 below for a summary of the variables discussed above.

Equation Coefficient	**SPSS Variable Code**	**Label**	**Description**	**Operationalized**	**Variable Type**	**Data Source**	**Literature Source**
Y	Y_PBAM	Y PBAM Productivity	Average monthly clinic RVUs per type II provider FTE per day	Continuous	Continuous	M2 and EAS IV	PBAM Handbook (2007) Ozcan(2005)
X1	X1_Tech	X1 Tech Proportion RVUs	Average monthly proportion of total RVUs generated by type IV providers	Continuous	Continuous	M2	Ozcan(2005)
X2	X2_NonB	X2 Non-B Proportion Available FTEs	Average monthly proportion of FTEs recorded in non-B functional cost codes	Continuous	Continuous	EAS IV	Ozcan(2005)
X3	X3_RVUs	X3 RVUs per Encounter	Average monthly number of RVUs per encounter	Continuous	Continuous	M2	Ozcan(2005)
X4	X4_Outpt	X4 Outpnt Proportion RVUs	Average monthly proportion of total RVUs performed in outpatient setting	Continuous	Continuous	M2	Ozcan(2005)

Figure 4. Code sheet summarizing the dependent and independent variables.

Methods

Experimental Design

The unit of analysis for this study is Army MTF physical therapy clinics. Of the 36 parent clinics Army-wide, 34 will be studied in the following two phases. See Appendix B for a complete list of MTFs with associated post and nearest city or country.

Statistical Process Control Phase

The experimental design of the first phase of this particular study is longitudinal SPC. It is considered longitudinal because it examines productivity on a monthly basis over the course of two fiscal years (statistical notation: $0_1 0_2 0_3 0_4 \ldots 0_{24}$). Data will be continuous in nature: RVUs per licensed physical therapist FTE per day. The SPC phase of the study seeks to identify the potential presence of special cause variation in PBAM productivity measures across the 34 Army PT clinics.

Multiple Linear Regression Phase

The experimental design for the second phase of the study is longitudinal multiple linear regression (MLR) analysis. It is considered longitudinal because it examines each variable on a monthly basis over the course of 2 fiscal years (statistical notation: $0_1 0_2 0_3 0_4 \ldots 0_{24}$). Continuous data includes RVUs, encounters and PT FTEs. Assuming that special cause variation is identified in the SPC phase, the MLR phase of the study will seek to identify and quantify predictors of PT PBAM productivity.

Hypotheses Statements

SPC Phase

The SPC phase of the study will evaluate the variation from the MEDCOM mandated productivity benchmark (17.32 RVUs/ Licensed PT FTE / Day) among Army PT clinics during

FYs 2006 and 2007. Applying SPC to PT clinic productivity will identify the presence of special cause variation and qualify the validity of the MEDCOM benchmark. The null (H_0) and alternate (H_a) hypotheses concerning Army PT clinics are:

H_0: No special cause variation is present among PBAM productivity measures.
H_a: Special cause variation is present among PBAM productivity measures.

MLR Phase

The MLR phase of this study will identify the sources of special cause variation through the application of regression analysis. The dependent variable is PBAM productivity and the independent or predictor variables are: 1) proportion of workload generated by technicians, 2) proportion of available FTEs recorded outside the B functional cost center, 3) RVUs per encounter and 4) proportion of total RVUs from an outpatient setting. Therefore, there are four pairs of null and alternate hypotheses related to the MLR equation: $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \in$ (error).

H_0: $b_1 = 0$ — 'Proportion of tech workload' *is not* a predictor of PBAM productivity.
H_a: $b_1 \neq 0$ — 'Proportion of tech workload' *is* a predictor of PBAM productivity.

H_0: $b_2 = 0$ — 'Non-B available FTEs' *is not* a predictor of PBAM productivity.
H_a: $b_2 \neq 0$ — 'Non-B available FTEs' *is* a predictor of PBAM productivity.

H_0: $b_3 = 0$ — 'RVUs per encounter' *is not* a predictor of PBAM productivity.
H_a: $b_3 \neq 0$ — 'RVUs per encounter' *is* a predictor of PBAM productivity.

H_0: $b_4 = 0$ — 'Proportion of outpatient RVUs' *is not* a predictor of PBAM productivity.
H_a: $b_4 \neq 0$ — 'Proportion of outpatient RVUs' *is* a predictor of PBAM productivity.

In more general terms, the null and alternate hypotheses are:

H_0: No independent variables are predictors of PBAM productivity.
H_a: At least one independent variable is a predictor of PBAM productivity.

Statistical Methods

SPC Phase

Statistical Process Control uses data to track processes in order to improve the quality of products and services (Ransom et al., 2005). Walter Shewart at Bell Laboratories defined the SPC concept for production processes during the 1920s (Cooper & Schindler, 2003). Shewart found that patterns of variation in processes often fell along a bell shaped curve or normal distribution. Shewart later developed a control chart to track and analyze variation in processes over time. SPC was not used extensively until after World War II when W. Edwards Deming used SPC in Japan to improve the quality of its products as it was rebuilding its economy (Ransom et al). According to Ransom et al, the use of SPC in health care has a number of benefits including: increased quality awareness, decision-making based on data, and improved processes, which result in improved health care outcomes and better quality care (2005).

SPC control charts distinguish common cause variation from special cause variation in processes. Common cause variation, due to inherent process randomness, is stable and predictable within given limits. Common cause events are generally not the focus of intervention. Special cause variation, due to correctable phenomena, is unstable and unpredictable within given limits. Special cause events warrant changes in practice and policy to reduce the process variation to within the given acceptable limits.

A control chart displays sequential measurements of a process together with a centerline plus upper and lower control limits (Cooper & Schindler, 2003). The control limit lines show the dispersion of data within a statistical boundary of generally three standard deviations above and three below the centerline. If an observation falls beyond the marked upper or lower control limits, there is evidence that the process is being adversely affected by special cause variation.

When considering variables data (ratio or interval measurements), data are typically presented in X-bar charts and R-charts. The X-bar chart is a plot of subgroup means. Means are tracked because they are more consistent than individual measures and are usually well approximated by a normal distribution. The X-bar chart will reveal whether there is special cause variation across subgroups. The R-chart is a plot of subgroup ranges. The R-chart will reveal whether there is special cause variation within each subgroup.

The first objective of this study is to apply statistical process control to identify the presence of special cause variation in Army PT clinic productivity. If clinics are indeed homogenous, one would expect little variation in productivity across the MTFs. Significant special cause variation due to fixed clinic characteristics, such as facility mission or mission-driven staffing ratios, indicates that the *one size fits all* benchmark methodology may be inappropriate. Special cause variation due to potentially modifiable characteristics or processes should be identified and targeted for intervention. Modifiable characteristics could include inconsistencies in coding, manpower reporting, or general efficiency. Because SPC only identifies the presence of special cause variation, regression analysis must be performed to identify what variables are actually contributing to the variation.

MLR Phase

Regression analysis and correlation analysis are used to measure the statistical relationship that exists between two or more variables. Simple regression and simple correlation deal with relationships between only two variables. When three or more variables are involved, the study deals with multiple regression and multiple correlation (Sanders & Smidt, 2000).

Regression analysis develops a predicting equation that describes the pattern of the relationship between the variables. The goal of multiple regression analysis is to predict the value of the dependent (or response) variable based on the values of multiple independent (or explanatory) variables. Whereas regression measures the pattern of the existing relationship, correlation analysis measures the strength of the relationship between the variables.

Multiple regression develops a set of partial regression coefficients b_k such that the dependent variable could be approximated by a linear combination of the independent variables, X (Abdi, 2003). Therefore, a predicted value, denoted $\hat{Y}$, of the dependent variable is expressed as: $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + \ldots b_kX_k + \in$

The objective of the MLR phase of this study is to identify the predictors of PBAM PT productivity. Multiple linear regression will identify which independent variables make significant contributions to productivity, and multiple correlation will indicate the strength of the relationship. Analysis of the four identified independent variables will yield the following equation: $\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \in$

$\hat{Y}$ is the estimated productivity based on the constant or y-intercept (b_0), the partial regression coefficients ($b_{1\text{-}4}$), the predictor variables ($X_{1\text{-}4}$), and the error ($\in$).

Several weaknesses are associated with regression-based approaches. First, regression analysis does not identify the *best in class* for benchmarking purposes. Efficient and non-efficient units are averaged into the overall sample. Second, regression-based approaches require parametric assumptions such as constant error variance and normal distribution of random errors. Using a parametric test such as MLR on non-normally distributed data may negatively affect validity of the study. Therefore, normality of data must be assessed prior to the application of MLR.

Tests for Normality

The SPC phase of this study is not limited to the examination of normally distributed data. In fact, the presence of special cause variation would cause the productivity data to exhibit a non-normal distribution. MLR analysis is a parametric test so validity is reliant on the normal distribution of the studied data. Numerous techniques, as described below, exist for determining the relative normality of data.

Histogram

Plotting the frequency distribution of each variable against the normal curve demonstrates the relative normality of the data. If the data is normally distributed, at least 67% of the distribution should fall beneath the normal curve. All of the variables except *outpatient proportion RVUs* meet this standard. See Table 2.

Z-score

A z-score is a standardized score indicating the relative position of each data point from the mean of the distribution measured in standard deviations. For example a data point lying 1 standard deviation from the mean would have a z-score of 1. Normally distributed data should have less than 1% of data points with z-scores beyond ± 2.5. Only *tech proportion RVUs* and *non-B proportion available FTEs* meet this standard. However, the other variables have 2.3% or less of their respective data points beyond z-scores of ± 2.5. See Table 2.

P-P Plot

If the distribution of the variable matches a normal distribution, the points will cluster around a straight line on a normality probability plot. This visual, subjective test is typically coupled with the Kolmogorov-Smirnov (K-S) test. All of the variables except *outpatient* *proportion RVUs* appear to have P-P plots that are nearly normal by visual observation. See Table 2.

TABLE 2

Normality Diagnostics for All Variables

Variable	Histogram points under normal curve	Points beyond ± 2.5 Z-score	P-P Plot Normality
Dependent:			
(Y) PBAM productivity	~80%	2.3% [a]	Nearly
Predictors:			
(X1) Tech proportion RVUs	~80%	0%	Very nearly
(X2) Non-B proportion available FTEs	~85%	.7%	Very nearly
(X3) RVUs per encounter	~85%	2.2% [a]	Nearly
(X4) Outpatient proportion RVUs	~40% [a]	1.8% [a]	Not [a]

Note. N = 816.
[a] Does not meet standards for normality

K-S Test

The K-S test produces a score from 0 to 1 with a score of 1 representing a perfectly normal distribution. No variables have a K-S test score of one, but *tech proportion RVUs* and especially *non-B proportion available FTEs* demonstrate values approaching one. See Table 3.

Skewness

Skewness is a measure of the distribution symmetry in regard to tails of the curve. A distribution with a long tail to the right is positively skewed and a distribution with a long tail to the left is negatively skewed. If the skewness value is less than two times the error of the skewness value, then the distribution is normal. Only *non-B proportion available FTEs* demonstrates no appreciable skew, but *tech proportion RVUs* has only a mild skew to the left. The other variables have significant skew as noted in Table 3.

Kurtosis

Kurtosis measures the peakedness of distribution. If the kurtosis value is less than two times the error of the kurtosis value, then the distribution is normal. Only *tech proportion RVUs* and *non-B proportion available FTEs* meet this standard. The other variables have significant kurtosis as noted in Table 3.

TABLE 3

Additional Normality Diagnostics for All Variables

Variable	K-S Test	Skewness (x error)	Kurtosis (x error)
Dependent			
(Y) PBAM productivity	.00 [a]	15.16 [a,b]	14.82 [a,d]
Predictors:			
(X1) Tech proportion RVUs	.02 [a]	-2.60 [a,c]	-1.74
(X2) Non-B proportion available FTEs	.15 [a]	.87	-.20
(X3) RVUs per encounter	.00 [a]	19.26 [a,b]	30.70 [a,d]
(X4) Outpatient proportion RVUs	.00 [a]	-26.26 [a,c]	29.33 [a,d]

Note. N = 816.
[a] Does not meet standards for normality
[b] Skewed with tail to right
[c] Skewed with tail to left
[d] Peaked

Sampling Plan

No sampling was performed for this particular study. Data was initially gathered from the entire population of 36 Army MTFs for FYs 2006 and 2007. After excluding Fox AHC and Patterson AHC due to missing data, the final data set consisted of 34 Army PT clinics measured for 24 months, yielding an N of 816 clinic-months.

Choosing the Alpha Level

Alpha (α) is the probability of making a *type I error*, or rejecting the null hypothesis when it is true. In the SPC phase of this study, a type I error would occur if special cause variation in PT clinics were identified, but, in reality, no special cause variation existed. In the MLR phase of this study, a type I error would occur if at least one independent variable were identified as a predictor of PBAM productivity when, in fact, no independent variables were predictors of PBAM productivity. A large α level will result in a higher likelihood of type I errors. However, a small α level may result in insufficient power to detect true effects when they exist.

Erroneously identifying special cause variation or predictors of PBAM productivity could result in unwarranted policy change and misuse of valuable resources. Therefore, it is highly desirable to avoid type I errors in this particular study. In addition, only highly significant predictors of PBAM productivity warrant the deployment of management resources. Overlooking a weakly predictive independent variable would not necessarily be deleterious to management of future PT productivity. Hence, considering the large sample size and desire to avoid type I errors, the α level was set at .01.

Power Analysis

Statistical power is the probability of getting a statistically significant result given a real effect in the studied population. Statistical power ranges from 0 to 1 and is calculated based on the estimated effect size, the alpha level, and the sample size. The effect size ranges from .1 to 1.0 and is concerned with the strength of relationships between variables. Smaller effect sizes are harder to detect and will require a larger sample. The alpha level is the odds that the observed result is due to chance. The sample size is the number of subjects studied. With a sample size of 816 (34 clinics x 24 months), this study has excellent statistical power considering even a small effect size at the chosen .01 α level.

TABLE 4

Power Analysis for PBAM Productivity

Effect Size	**.10**	**.20**	**.30**	**.40**	**.50**
Power at $\alpha = .05$	.81	1.0	1.0	1.0	1.0
Power at $\alpha = .01$	.60	1.0	1.0	1.0	1.0

Note. N = 816. Table values from Cohen (1988).

Data

Data Sources

FTE data was queried from the EAS IV database. The final EAS IV data query was performed on February 19, 2008. RVU and encounter data were queried from M2. The final M2 data query was performed on January 24, 2008. All data was queried at the treatment parent DMIS ID (Defense Medical Information System Identifier) level. Therefore, any data from a *child* clinic, such as a satellite clinic, is aggregated under the parent clinic at the MTF.

Data Query Specifics

PBAM productivity was calculated by querying from M2, the monthly RVUs recorded under the BLA FCC within each Army parent DMIS ID. Then, EAS IV was queried for monthly FTEs recorded by Type II providers under the BLA FCC. The average daily productivity calculation equals the clinic monthly RVUs / Type II monthly FTEs / 21 days per month. The PBAM methodology considers each month to have 21 business days regardless of the actual number of business days.

Tech proportion RVUs was calculated by querying from M2, the monthly RVUs performed under the BLA FCC by provider specialty code. Total clinic RVUs and RVUs associated with the code 900 (Corpsman/Technician) were used to derive the proportion of the workload performed by technicians.

Non-B proportion available FTEs was calculated by querying from EAS IV, the monthly FTEs recorded by physical therapists under any FCC. The query was limited to the physical therapist specific service occupation codes: 65B, 0633 and 1873O. Contract chiropractors are also coded as 65B, so any FTEs recorded under the BEDA (Chiropractic Clinic) FCC were excluded from the calculation. The non-B proportion of available FTEs is the proportion of monthly FTEs recorded in all FCCs other than B.

RVUs per encounter were derived entirely from M2 data. This independent variable is the quotient of monthly RVUs and monthly encounters recorded under the BLA FCC.

Outpatient proportion RVUs was derived from M2 data. Monthly RVUs under the BLA FCC were queried using the inpatient indicator discriminator. This final independent variable is the quotient of monthly outpatient RVUs and total RVUs.

Data Quality

Concerning data quality and validity, M2 and EAS IV data are only as accurate as the key-strokes entered at the clinician level. Despite these data quality concerns, the M2 and EAS IV databases are the tools available to military health care executives. Visual examination of the data as a physical therapist revealed no obviously aberrant data points, so no MTFs were excluded on the basis of face validity.

Assessment of Missing Data

Of the 36 Army MTFs, 2 were excluded due to a lack of available data. Patterson AHC was missing 10 months of FTE data and Fox AHC was missing the first 6 months of RVU and FTE data from FY 2006. Of the remaining 34 Army MTFs, no RVU data was missing, but 7 clinics had missing FTE data for one or more months of FY 2007 (See Table 5). A 3-month moving average was used to replace each month of missing FTE data, theorizing that future FTE levels are accurately predicted by the past 3 months of known FTE data.

TABLE 5

Facilities with Missing FY 2007 FTE Data

Military Treatment Facility	Post	Missing Month(s)
Brooke AMC	Fort Sam Houston, TX	Jun, Jul, Aug, Sep
Evans ACH	Fort Carson, CO	Sep
BG Crawford Sams AHC	Camp Zama, Japan	Sep
Blanchfield ACH	Fort Campbell, KY	Aug, Sep
Eisenhower AMC	Fort Gordon, GA	Aug, Sep
Madigan AMC	Fort Lewis, WA	Aug, Sep
Weed AHC	Fort Irwin, CA	Sep

Outlier Analysis

Outlying data points were identified by MTF-month for each variable, but no MTFs were excluded from the study on this basis. Although excluding some MTFs from the study would have improved the normality of the data sets, such exclusions would have decreased the comprehensiveness and generalizability of the research. See Appendices C-F for scatter plots identifying outliers for each variable.

Instrumentation

All statistical calculations were performed using the Statistical Package for the Social Sciences (SPSS), Version 12.0.

Results

Hypothesis Discussion

SPC Phase

Based on the findings of the SPC portion of the study, the null hypothesis (no special cause variation is present among PBAM productivity measures) was rejected. The results support the hypothesis that statistically significant special cause variation in PBAM productivity measures exists across Army PT clinics during FYs 2006 and 2007.

MLR Phase

Based on the findings of the MLR portion of the study, the null hypothesis (no independent variables are predictors of PBAM productivity) was rejected.

The results support that each of the four independent variables were statistically significant predictors of PBAM productivity measures across Army PT clinics during FYs 2006 and 2007.

Quantitative Analysis Review

SPC Phase

A mean chart and range chart were selected as appropriate control graphs to analyze PBAM productivity, given the continuous data (FTEs and RVUs) that was queried.

Mean Chart.

Using the mean-range approach, the mean chart (Figure 5) was constructed by displaying each MTF's mean productivity against the population mean productivity and control limits. The range for each MTF was calculated by subtracting the minimum productivity value from the maximum productivity value during the 24-month period. The average of ranges was then calculated as R-bar *(R-bar = 20.16)*. Sample means were determined for each MTF by averaging the monthly observations. The population mean productivity (x-bar-bar = 18.73) was determined by dividing the 24-month total of RVUs by the 24-month total of FTEs and then dividing by 21 days. This method of calculating a *weighted* population mean was chosen so that an MTF's contribution to the mean would be proportional to the RVUs generated by that MTF, thus yielding a realistic picture of average Army PT clinic productivity. Alternately, averaging the individual clinic productivity values would yield an unrealistically high average productivity due to the large number of highly productive ACHs and AHCs. Using the weighted population mean and the population's average range, control limits were calculated using the A_2 factor (0.157 for $n = 24$) provided in Appendix G. The Upper Control Limit (UCL) was established at 21.90, and the Lower Control Limit (LCL) was established at 15.56. The following equations were used:

$$\bar{x} = \frac{\sum x_i}{n} \qquad \bar{\bar{x}} = \frac{\sum \bar{x}}{k} \qquad \bar{R} = \frac{\sum r_k}{k} \qquad UCL = \bar{\bar{x}} + A_2 \bar{R} \qquad LCL = \bar{\bar{x}} - A_2 \bar{R}$$

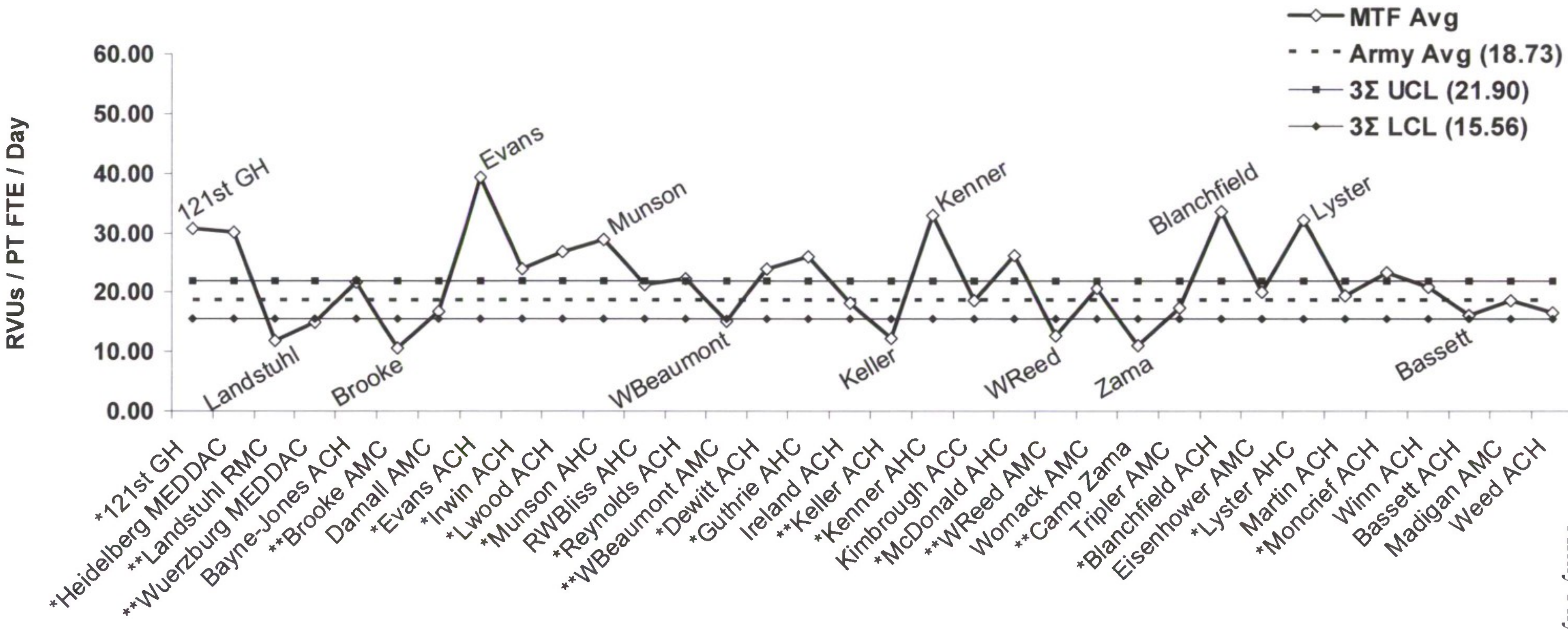


Figure 5. Mean chart displaying variation from the mean PBAM productivity across Army PT clinics. With 99.7% confidence, fluctuation of data points within the control limits (±3Σ) are the result of common causes and data points beyond the UCL or LCL are the result of special causes. Facilities with one asterisk exceed the UCL and facilities with two asterisks fail to reach the LCL. Notice that four large medical centers (Landstuhl, Brooke, William Beaumont and Walter Reed) fall below the LCL. According to the PBAM productivity methodology, Evans ACH appears to be approximately four times as productive as Brooke AMC.

Range Chart. A range chart (Figure 6) was constructed by displaying each MTF's productivity range against the population mean range and control limits. The individual MTF productivity ranges and the average of ranges *(R-bar = 20.16)* were used for the range chart calculations. A D_4 factor of 1.548 (See Appendix G) was obtained for 24 observations in each MTF and used to calculate the UCL at +3σ. The LCL was calculated for -3σ using the D_3 factor of .452 (See Appendix G). The following equations were used:

$$UCL = D_4\overline{R} \qquad LCL = D_3\overline{R}$$

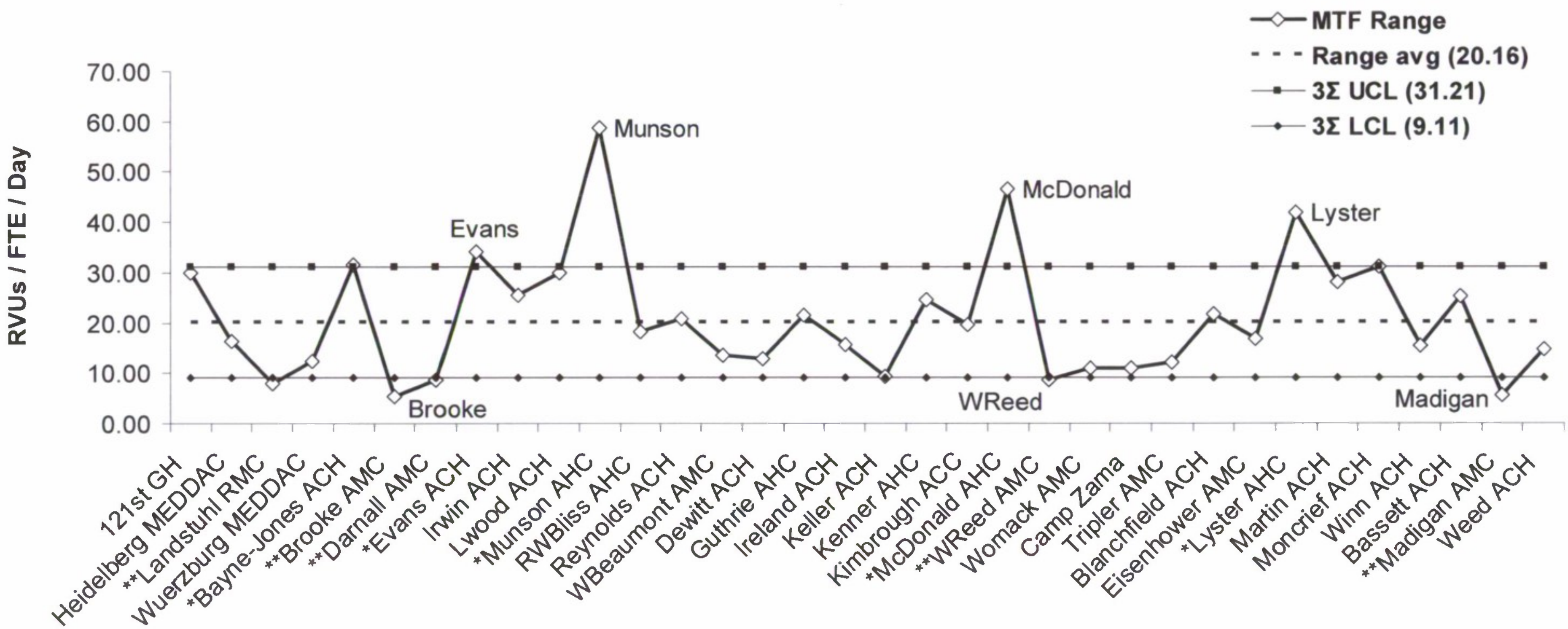


Figure 6. Range chart displaying the variation in PBAM productivity measures among individual Army PT clinics. With 99.7% confidence, fluctuation of data points within the control limits ($\pm 3\Sigma$) are the result of common causes and data points beyond the UCL or LCL are the result of special causes. Facilities with one asterisk exceed the UCL and facilities with two asterisks fail to reach the LCL. Baynes-Jones ACH, Evans ACH, Munson AHC, McDonald AHC and Lyster AHC display variation in excess of that expected from common cause variation alone.

MLR Phase

Descriptive Statistics.

Table 6 provides a snapshot of Army PT clinic productivity and the four identified predictors. The mean PBAM productivity across Army PT clinics during FYs 2006 and 2007 was 22.65 RVUs / FTE / Day. This number is higher than the aggregate productivity average of 18.73 due to the high number of smaller clinics with relatively high productivity. On average, technicians produce 33% of each clinic's RVUs, and therapists actively provide patient care 62% of the time that they are present at the MTF. Each physical therapy encounter generates an average of .85 RVUs, and 96% of the average PT clinic's workload is produced in the outpatient setting. All four predictors demonstrate significant positive correlations with PBAM productivity at the 99% confidence level.

TABLE 6

Descriptive Statistics for All Army MTFs except Fox and Patterson AHCs

Variable	Mean	SD	Correlations (r)
Dependent			
(Y) PBAM productivity	22.65	9.90	1.00
Predictors:			
(X1) Tech proportion RVUs	.33	.16	.42*
(X2) Non-B proportion available FTEs	.38	.16	.25*
(X3) RVUs per encounter	.85	.17	.37*
(X4) Outpatient proportion RVUs	.96	.07	.37*

Note. N = 816.
* $p < .01$.

FY 2006 vs. 2007.

As shown in Table 7, from FY 2006 to FY 2007, the average, aggregate and median PBAM productivity increased. In addition, the minimum annual average productivity increased and the maximum annual average decreased as the variation across MTFs decreased. Finally, a net of six clinics moved from an inefficient to an efficient status as defined by meeting or exceeding the PBAM productivity goal of 17.32 RVUs / FTE / day. Much of this improvement appears to be a result of a greater proportion of workload credited to technicians.

TABLE 7

Summary of PBAM Productivity Measures for All Army MTFs except Fox and Patterson AHCs

	FY 2006	**FY 2007**
N =	34	34
Average productivity	22.55	22.75
Aggregate productivity	18.15	19.29
Median productivity	20.84	21.32
Minimum annual average	10.29	10.66
Maximum annual average	48.52	36.91
Standard deviation	10.78	8.95
Proportion of RVUs from techs	.31	.35
Number of efficient MTFs	21 (61.8%)	27 (79.4%)
Number of inefficient MTFs	13	7

Note. MEDCOM benchmark for FY 2006 and 2007 = 17.32.

Multiple Linear Regression Analysis.

Regression analysis revealed that the four independent variables make statistically significant contributions to variation in the dependent variable, PBAM productivity. The R^2 value or coefficient of determination indicates that 41.9% of the variance in PBAM productivity measures can be predicted by the four independent variables. This is an overall measure and does not reflect the extent to which any particular independent variable is associated with the dependent variable. The F value of 146.00 suggests that the independent variables reliably predict the dependent variable at the $\alpha = .01$ level.

The first variable in Table 8 is the constant or Y intercept. The unstandardized coefficients (*B*) are combined to form the regression equation which predicts the PBAM productivity value based on the predictor variable values. The standard errors (*SE B*) test whether the unstandardized coefficients are significantly different from zero. The standardized coefficients (β) allow comparison of the magnitude of effect on PBAM productivity. All independent variables are statistically significant at the $p < .01$ level. *Tech proportion RVUs* makes the greatest contribution to PBAM productivity followed in descending order by *RVUs per encounter*, *Outpatient proportion RVUs* and *Non-B proportion available FTEs*.

TABLE 8

Summary of Multiple Linear Regression Analysis of All Army MTFs except Fox and Patterson AHCs

Variable	***B***	***SE B***	**β**
(Constant)	-37.54	3.78	
Tech proportion RVUs	23.31	1.73	.38*
Non-B proportion available FTEs	12.08	1.68	.20*
RVUs per encounter	21.69	1.63	.37*
Outpatient proportion RVUs	30.56	4.01	.21*

Note. $R^2 = .419$; Adjusted $R^2 = .416$; $F = 146.000$; Regression Equation: $y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \in$; $y = -37.54 + 23.31x_1 + 12.08x_2 + 21.69x_3 + 30.56x_4 + \text{Error}$.
* $p < .01$

Colinearity Diagnostics.

Although the independent variables display statistically significant colinearity, as displayed in Table 9, none of the correlations are higher than .206. The strongest correlation for each independent variable is with the dependent variable. The correlation table indicates a low degree of colinearity between the dependent variables.

TABLE 9

Correlation Table for All Variables

Variable	**Y**	**X1**	**X2**	**X3**	**X4**
Dependent:					
(Y) PBAM productivity	1.000	.365*	.420*	.367*	.249*
Predictors:					
(X1) Tech proportion RVUs	.365*	1.000	-.079	.206*	-.084*
(X2) Non-B proportion available FTEs	.420*	-.079	1.000	.177*	.187*
(X3) RVUs per encounter	.367*	.206*	.177*	1.000	.064
(X4) Outpatient proportion RVUs	.249*	-.084*	.187*	.064	1.000

Note. N = 816.
* $p < .01$.

Autocorrelation Diagnostics

The Durbin-Watson statistic ranges from 0 to 4; a value near 2 indicates no autocorrelation. The Durbin-Watson score for the regression analysis in this study was .493 which indicates significant positive serial correlation. In other words, the error terms from one time period are positively correlated with errors in the next time period. Visual evidence of autocorrelation exists in Figure 7 as demonstrated by the positive regression line in the scatter plot correlating PBAM productivity in FY 2006 with FY 2007. The consequences of serial correlation are discussed in the *Error Diagnostics* section.

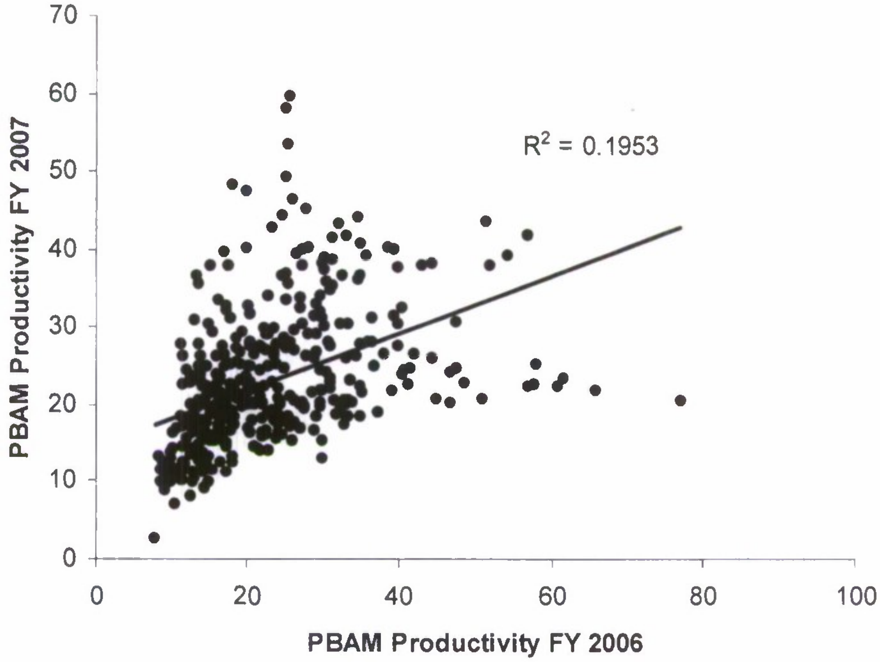


Figure 7. Scatterplot demonstrating the autocorrelation of PBAM productivity

Reliability

Every measure is considered the sum of the true score and error. A measure is considered reliable if it gives the same result over and over again. Because the true score is impossible to determine, reliability can only be estimated.

The data for this particular study was queried from the M2 and EAS IV databases which are only as reliable as the data entered at the user level. In addition, retroactive updates of the databases may change the current values of the data used in this study. Therefore, any attempt to replicate this study in the future may produce numerically different results.

Validity

The validity of this study concerns the adequate operationalization of the constructs (Army PT clinics and efficiency) and the ability of the predictor variables to accurately predict change in PBAM productivity. In other words, is the study actually measuring what it purports to measure?

In order to support the proposition that Army PT clinics are efficient, *Army PT clinics* and *efficient* must be operationalized into measurable variables. Army PT clinics are frequently described in terms of staffing, workload coding practices and MTF mission, so the proposed operationalization is supported by the concept of face validity. The specific reasoning behind the construct operationalization is discussed in the *Constructs, Variables and Measures* section. The validity of the RVU and FTE data used to define Army PT clinics is only as good as the information entered at the user level. Hence, it is impossible, beyond face observation, to determine how closely the reported RVUs and FTEs actually represent the procedures performed and hours engaged in work.

Efficient, generally characterized by minimal input producing maximal output, was operationalized as RVUs / FTE / Day according to the PBAM productivity methodology. However, the validity of the PBAM productivity measure is suspect because it does not reflect all of the inputs (FTEs) used to generate the outputs (RVUs). Though the PBAM productivity measure includes all of the outputs of the PT clinic, it fails to include the inputs of the technicians. However, because the PBAM methodology is the standard measure of productivity within the Army Medical Command, it was the most logical choice of a dependent variable to operationalize *efficient.*

The predictive validity of the independent variables is supported by the strong correlations to PBAM productivity. Correlation coefficients ranged from .25 to .42 and were all statistically significant at $p < .01$. These strong correlations support the proposition that Army PT clinics (defined by staffing, workload coding and mission) are efficient (defined by the PBAM productivity measure).

Error Diagnostics

Type I and II errors must be considered when testing a hypothesis. A type I error is a false positive, or the risk that a true null hypothesis will be rejected. In this study, a type I error would occur if, in actuality, none of the dependent variables predicted PBAM productivity but, statistically, at least one of the dependent variables was found to be predictive. A type II error is a false negative, or the risk that a false null hypothesis will be accepted. In this study a type II error would occur if, in actuality, at least one of the dependent variables predicted PBAM productivity but, statistically, no dependent variables were identified as predictive.

Two characteristics of the examined data increase the likelihood of a type I error: Non-parametric data and autocorrelation. As previously discussed in the *tests for normality* section, none of the variables have absolutely normal distributions, but *outpatient proportion RVUs* in particular demonstrates a distribution that is far from normal. Using regression analysis with data that is not perfectly normal increases the likelihood of a type I error. As previously discussed in the *autocorrelation* section, the low Durbin-Watson score indicates significant positive serial correlation. Proceeding with the MLR analysis despite the presence of autocorrelation will result in downwardly biased errors of the least squares estimates. Consequently, the null hypothesis may be rejected when it should not be. In addition, the R^2 value will be higher than it should be. In defense of the MLR findings, the actual p value associated with MLR was 5.19×10^{-94}, indicating an extremely low probability of committing a type I error despite the autocorrelation.

For this particular study, the primary control for type I error is the α level. By setting α at .01 instead of .05, this lowers the risk of a type I error from 5 in 100 to 1 in 100. Additionally, the large number of facility-months (816) examined increases the statistical power of the study and decreases the likelihood of erroneously identifying an independent variable as predictive. Considering 34 of the existing 36 Army PT clinics further controls for type I error by virtually eliminating the possibility of sampling error affecting generalizability to the population. Finally, the use of continuous rather than categorical variables increases the power of the study and decreases the likelihood of a type I error.

As the likelihood of a type I error (α) decreases, the likelihood of a type II error ($\beta = 1 - \alpha$) increases. Choosing an α of .01 increases the likelihood of a false negative, or failing to detect the predictive ability of an independent variable. In the case of this study, accepting the greater risk of a type II error compared to a type I error is based on the desire to avoid committing significant resources to changing a variable that is only minimally predictive of PBAM productivity. In retrospect, the p values associated with the predictive ability of each independent variable are well below the .01 level. Therefore, the selected α level of .01 did not result in the exclusion of any of the predictor variables.

For this particular study, all four of the independent variables were found to be predictive of PBAM productivity so the null hypothesis was rejected. Therefore, only a type I error could have been committed, the odds of which are 1 in 100 at the .01 α level.

Discussion

As the PBAM gains momentum as a tool for leveraging MTF performance, it becomes more critical that each commander, administrator and clinician understand the various methodologies employed by the PBAM to modify MTF funding. Because PT clinics are not directly involved with HEDIS measures or most inpatient lengths of stay, PT clinics can make the most impact on their MTF's funding by understanding the PBAM productivity calculations and specialty-specific targets. To effectively optimize clinical productivity, PT clinics must understand the PBAM productivity methodology and the factors affecting PBAM productivity. In addition, there is the underlying question of the appropriateness of the PBAM productivity methodology and its application across all clinics regardless of staffing levels or MTF mission. Therefore, this study was undertaken to quantify PBAM productivity variation across Army PT clinics, identify predictors of PBAM productivity and propose alternatives to the *one size fits all* productivity targets.

SPC Phase

The SPC phase of the study utilized statistical process control to identify and quantify special cause variation in PBAM productivity across Army PT clinics. The null hypothesis (no special cause variation exists) suggested that any variation was due to random chance alone. This was easily rejected based on the mean chart analysis as displayed in Figures 5 and 6.

Mean Chart

The mean chart analysis reveals substantial special cause variation in PBAM productivity measures across Army PT clinics, indicating the need for further process investigation. The PBAM methodology for calculating productivity considers the RVUs produced by the entire clinic but only includes the FTEs of the physical therapists. Because the calculation does not include the technician FTEs, any variation in technician staffing across MTFs could significantly alter productivity measures. A second source of special cause variation could be coding and manpower recording practices that lead to variation in productivity measures. Finally, a third potential source of special cause variation is fixed MTF characteristics such as the facility mission. For example, large AMCs generally have a robust inpatient mission resulting in higher acuity patients. This anecdotally results in a therapist-heavy staff spending a greater amount of time treating complicated patients. In light of these potential predictors of PBAM productivity, the MLR phase of this study was undertaken to identify the contribution of staffing, manpower reporting, workload coding and MTF mission.

Range Chart

The range chart analysis reveals that special cause variation is affecting the productivity measure dispersion within the five MTFs that fall above the UCL (Bayne-Jones ACH, Evans ACH, Munson AHC, McDonald AHC, Lyster AHC). The five AMCs with productivity ranges below the LCL are not a concern because these facilities show less than statistically expected process dispersion. Due to the large staff and volume of patients in AMCs, productivity measures generally vary little from month to month. The five MTFs with widely varying productivity dispersion may have been affected by changing staffing levels during the analyzed time period. Additionally, these small clinics may not have standardized procedures for coding and manpower recording, resulting in the perception of wide monthly productivity swings.

MLR Phase

The MLR phase of the study clearly identifies four predictors of increased PBAM productivity within Army PT clinics: 1) the proportion of work performed by the technicians, 2) the proportion of FTEs recorded in non patient care FCCs, 3) the number of RVUs coded per encounter and 4) the proportion of outpatient-centered care. These four predictors account for roughly 42% of the variation in PBAM productivity within Army PT clinics during FYs 2006 and 2007. In addition, multiple linear regression yields a regression equation that quantifies the relationship between PBAM productivity and the independent variables.

X1: Tech proportion RVUs

As the independent variable, *tech proportion RVUs* increases, PBAM productivity increases. This relationship is likely due primarily to the PBAM methodology. Because the PBAM model does not consider technician FTEs in the denominator, increasing technician-produced RVUs has a strongly positive effect on PBAM productivity. Examining the regression equation shows that for every .1 increase in the proportion of tech workload, PBAM productivity will increase by 2.3 RVUs per FTE. This partly explains the large productivity differences between facilities such as Walter Reed AMC (13% of work performed by techs) and Evans ACH (61% of work performed by techs).

Comparing *tech proportion RVUs* across different hospital types (See Table 10) reveals that ACHs tend to have a greater proportion of work performed by technicians. AHCs have the lowest mean proportion of work performed by techs but also display the greatest standard deviation. The technician workload discrepancy between and within hospital types warrants further discussion.

TABLE 10

Comparison of Mean Tech Proportion RVUs by Hospital Type

Hospital Type	**N**	**Mean**	**SD**	**Range of Means**
Medical Center (AMC)	216	.32	.14	.13 to .52
Community Hospital (ACH)	408	.36	.16	.12 to .61
Health Clinic (AHC)	192	.30	.18	.00 to .50

Note. A one-way ANOVA and Tamhane's T2 post hoc test show that the ACH mean is significantly greater than the AMC and AHC means ($p < .01$).

M2 data may not reflect the actual technician workload in some facilities because tech RVUs are reported under the supervising therapist. This practice is in opposition to current coding guidance, but was a common occurrence at the beginning of FY 2006. Examining the individual monthly data indicates that Walter Reed AMC, DeWitt ACH, Kimbrough ACH and Kenner AHC were reporting negligible technician work during the first six months of FY 2006. Reynolds ACH reported no technician RVUs during FY 2006 and through the third month of FY 2007, but, by the final fiscal month was reporting 45% of RVUs as tech-generated.

A second potential source of tech workload variation is the facility mission and consequent patient acuity. Facilities such as Brooke AMC and Walter Reed AMC have a robust inpatient mission that includes amputee, neurological and geriatric care. Conversely, smaller ACHs such as Evans and Reynolds have negligible inpatient missions and a large number of young active duty troops. Anecdotally, the higher acuity patients at the large medical centers require a higher proportion of physical therapists that can perform complicated rehabilitation regimens. Although this proposition has face validity, it fails to explain why some AMCs display relatively high proportions of technician workload. For example, Tripler AMC, despite having an inpatient workload similar to Brooke AMC, reports that technicians generate 45% of the total clinic RVUs. Only 14% of Brooke AMC's PT clinic workload is reportedly generated by technicians.

The third and final potential source of tech workload variation is related to business practices. Perhaps the low technician workload in select facilities is due to faulty staffing models. It is possible that some facilities such as Brooke AMC, Walter Reed AMC, DeWitt ACH and Guthrie AHC are understaffed in terms of technician support. Appendix H shows the average variable values in each individual MTF. This understaffing results in therapists performing treatments that could be carried out competently by a qualified technician. Consequently, PBAM productivity suffers and the cost per RVU of care rises due to the higher cost of employing therapists to do technician work.

X2: Non-B proportion available FTEs

As the independent variable, *non-B proportion available FTEs* increases, PBAM productivity increases. Recording less time performing patient care and more time performing administrative, education and readiness tasks lessens the denominator in the PBAM productivity calculation. Consequently, productivity rises. Examining the regression equation shows that for every .1 increase in the proportion of non-B available FTEs, PBAM productivity will increase by 1.2 RVUs per FTE. This partly explains the relatively low productivity (19.88) of Kimbrough Ambulatory Care Center that recorded 90% of available time as seeing patients and only 10% of available time as performing non-patient care tasks.

Comparing *non-B proportion available FTEs* across different hospital types (See Table 11) reveals that AHCs tend to report a lesser proportion of non-patient care time. This is intuitively logical because AHCs have small PT clinics that require less time committed to administrative tasks.

TABLE 11

Comparison of Mean Non-B Proportion Available FTEs by Hospital Type

Hospital Type	**N**	**Mean**	**SD**	**Range of Means**
Medical Center (AMC)	216	.38	.11	.25 to .49
Community Hospital (ACH)	408	.40	.16	.27 to .70
Health Clinic (AHC)	192	.32	.19	.10 to .64

Note. A one-way ANOVA and Tamhane's T2 post hoc test show that the AMC and ACH means are significantly greater than the AHC mean ($p < .01$).

Looking further into the FTE data reveals that the European facilities (Landstuhl, Heidelberg and Wuerzburg) record less than half of their available FTEs as providing patient care in the BLA clinic. However, these three facilities record 24.5% of time available in FBJ (Early Intervention Services) and FBK (Medically Related Services). According to the European Regional Medical Command PT consultant, the FBJ and FBK codes are used by civilian physical therapists under the MTF command that spend a majority of their time providing care in the local school system (S. Lynch, personal communication, April 14, 2008).

A concerning characteristic of the FTE data is the wide variation in the proportion of available time reported as performing patient care. As seen in Table 11, large ranges of non-B available FTE time exist within and across hospital types. For example, among AMCs, Darnall and Madigan record approximately 50% of their time as doing activities other than patient care. Walter Reed, on the other hand, records only 25% of therapist FTEs doing other than patient care activities. This wide variation could be due to inaccurate FTE reporting, true differences among clinics, *gaming* of the system or, more likely, a combination of the three.

X3: RVUs per encounter

As the independent variable, *RVUs per encounter* increases, PBAM productivity increases. This finding indicates that facilities can increase productivity by documenting and subsequently coding in an RVU-optimizing manner. Examining the regression equation shows that for every .1 increase in RVUs per encounter, PBAM productivity will increase by 2.2 RVUs per FTE. This partly explains the relatively high productivity (33.28) of Kenner AHC that recorded 1.40 RVUs per encounter during the 24-month time period.

Comparing *RVUs per encounter* across different hospital types (See Table 12) reveals that as facility size increases, coding optimization decreases. This finding is disturbing because it refutes the supposition that treating higher acuity patients at AMCs requires more provider time and results in more procedures per encounter. In addition, because the nine AMCs generate more than 40% of the total Army PT RVUs, the low RVUs per encounter has a significant negative effect on the aggregate PBAM productivity.

TABLE 12

Comparison of RVUs per Encounter by Hospital Type

Hospital Type	N	Mean	SD	Range of Means
Medical Center (AMC)	216	.76	.09	.64 to .92
Community Hospital (ACH)	408	.84	.13	.65 to 1.04
Health Clinic (AHC)	192	.97	.23	.75 to 1.40

Note. A one-way ANOVA and Tamhane's T2 post hoc test show that the AMC mean is significantly less than the ACH mean which is significantly less than the AHC mean ($p < .01$).

The low RVU per encounter at AMCs could be due to several issues. First, perhaps AMCs truly perform less work per encounter than ACHs and AHCs. This seems unlikely since most Army physical therapists receive similar training and practice in a similar manner. Second, perhaps AMCs do not understand how to code optimally. Although the addition of coders and coding coaches at the clinic level ensures coding is consistent with documentation, it does not necessarily address practicing and documenting in a manner that optimizes RVU production. Third, it is possible that AMCs are not getting appropriate credit for long treatments due to the SADR's inability to capture multiple units of the same procedure. Finally, AMC size may prevent the efficient dissemination of coding information and oversight of coding practices. It requires less time and resources to train and audit the coding of a small AHC staff of 5 compared to a large AMC staff of 40. Despite the tendency for low RVUs per encounter in AMCs, this does not necessarily have to be the norm. The coding performance of Brooke AMC (.92 RVUs per encounter) far surpasses the mean of .76, suggesting that the other AMCs are possibly undercoding.

X4: Outpatient proportion RVUs

As the independent variable, *outpatient proportion RVUs* increases PBAM productivity increases. This finding indicates that facilities with a predominantly outpatient mission tend to have greater productivity. Examining the regression equation shows that for every .1 increase in the proportion of outpatient care, PBAM productivity will increase by approximately 3.1 RVUs per FTE. Conversely, for every .1 increase in the proportion of inpatient care, clinic productivity is expected to decrease by approximately 3.1 RVUs per FTE. Anecdotally, inpatient PT is less efficient than outpatient PT due to unproductive time spent waiting for unavailable patients, coordinating care with other providers, and physically walking through the facility.

Comparing *outpatient proportion RVUs* across different hospital types (See Table 13) confirms the logical expectation that AMCs perform more inpatient care than ACHs or AHCs. The regression equation suggests that sustaining a large inpatient mission has a substantial negative impact on productivity. Therefore, if all other variables are equal, an AMC such as Walter Reed can expect a 9 RVU/FTE decrease in productivity due to a robust inpatient mission generating 29% of that clinic's RVUs. This finding suggests that AMCs with robust inpatient missions will likely struggle to meet the current PBAM productivity targets.

TABLE 13

Comparison of Outpatient Proportion RVUs by Hospital Type

Hospital Type	N	Mean	SD	Range of Means
Medical Center (AMC)	216	.87	.08	.71 to .99
Community Hospital (ACH)	408	.99	.02	.94 to 1.00
Health Clinic (AHC)	192	1.00	.01	1.00 to 1.00

Note. A one-way ANOVA and Tamhane's T2 post hoc test show that the AMC mean is significantly less than the ACH mean which is significantly less than the AHC mean ($p < .01$).

Y: PBAM productivity

Comparing *PBAM productivity* across different hospital types (See Table 14) reveals that the AMC mean is significantly less than that of the ACH and AHC means. Having examined the relationship between the independent variables and hospital size, this finding is not surprising. AMCs tend to have less work performed by technicians, record fewer RVUs per encounter and report a greater number of inpatient-related RVUs. Combining the two relatively fixed factors of technician work and inpatient work, the regression equation predicts that the average AMC should produce approximately 4.6 fewer RVUs per FTE compared to the average ACH. This prevents many AMCs (Landstuhl, Brooke, Darnall, William Beaumont and Walter Reed) from meeting the PBAM productivity target of 17.32 RVUs / FTE / Day. Consequently, MEDCOM's application of one PBAM benchmark across all MTFs, regardless of size, may contribute to a perception that medical centers are not productive. The inability of these AMC PT clinics to contribute to their respective product line productivity could ultimately result in a decrement of the respective MTF's funding.

TABLE 14

Comparison of PBAM Productivity by Hospital Type

Hospital Type	N	Mean	SD	Range of Means
Medical Center (AMC)	216	16.30	4.55	10.76 to 20.91
Community Hospital (ACH)	408	24.24	9.39	12.29 to 40.29
Health Clinic (AHC)	192	26.41	11.91	11.23 to 36.20

Note. A one-way ANOVA and Tamhane's T2 post hoc test show that the AMC mean is significantly less than the ACH and AHC means ($p < .01$).

Conclusions and Recommendations

The Army Medical Command continues to focus on improving operational and fiscal effectiveness. In a 3 April 2008 memorandum from LTG Eric Schoomaker, Army Surgeon General and Commander of the Army MEDCOM, the PBAM is identified as one of four strategic performance enablers. The Surgeon General describes the PBAM as the mechanism by which the MEDCOM modifies MTF funding based on actual medical outcomes compared to performance goals. He states, "The PBAM promotes best-evidence based practices by aligning resource allocation with desired behaviors and business objectives that incentivize clinicians, administrators and commanders. We will continue to evolve and leverage PBAM to improve our performance." Based on the Surgeon General's emphasis, it is crucial that the PBAM is critically examined as an effective tool for modifying MTF funding. In addition, the Army PT community must understand the PBAM methodology and what factors are predictive of PBAM productivity. Finally, Army physical therapists must leverage knowledge of the PBAM to maximize productivity where possible, or, alternatively, explain the perceived lack of productivity resulting from inherent shortcomings in the PBAM productivity methodology.

The SPC phase of this study demonstrated that wide variation in productivity exists across Army PT clinics. Of particular note, Landstuhl RMC, Brooke AMC, Walter Reed AMC and William Beaumont AMC all reported productivity below the lower control limit and well below the FY 2007 PBAM productivity target of 17.32 RVUs / FTE / Day. This suggests that PT clinic business practices are not standardized, that PT clinics are not homogenous, or that the PBAM methodology is not an effective tool for comparing productivity across all Army PT clinics. Therefore, the MLR phase of this study was conducted to identify potential predictors of variation in PBAM productivity. Four predictors were found to be responsible for 42% of the variation in PBAM productivity: 1) the proportion of work performed by the technicians, 2) the proportion of FTEs recorded in non-patient care FCCs, 3) the number of RVUs coded per encounter and 4) the proportion outpatient-centered care. Based on the above findings and previous discussion, the following courses of action are recommended:

Productivity Optimization

The Army PT community must optimize productivity in order to be competitive with the civilian sector and prove that Army PT provides excellent care in an efficient and fiscally responsible manner. Productivity optimization will only occur through clinician education, metrics development / proliferation, and coding standardization leveraged toward the adoption of best business practices.

Clinician Education

It is crucial that Army physical therapists develop an understanding of the drivers behind decision making at the MTF and OTSG level. This understanding must include how the PBAM productivity methodology is applied at the clinic and product line level to adjust MTF funding. Specifically, clinic chiefs must understand the PBAM productivity calculations, know how to optimize clinic RVU production, and effectively communicate this knowledge to junior clinicians. Part of this education is emphasizing the need to document and code accurately in order to get credit for work performed. Optimizing productivity does not necessarily mean working harder.

This required education is best accomplished through a comprehensive and multifaceted approach. First, distribute an executive summary of this study to each Army physical therapist and mandate reading for each clinic chief. Second, schedule teleconferences and video teleconferences to brief a large audience of therapists and offer opportunities to address questions. Third, offer periodic productivity articles in the SP Corps Connection to proliferate PBAM methodology knowledge. Finally, add SP Corps business practice briefings, including productivity, to the Corps or track day curriculums of the Captain's Career Course, the Basic Officer Leadership Course and other administrative short courses. Effective PT-wide education is key to proliferating best business practices aimed toward institutionalizing optimial clinic productivity.

Metrics Development and Proliferation

In order to effectively optimize productivity, each clinic must have a clear metric-driven action plan for achieving a meaningful goal. However, there is currently a relative dearth of business metrics within Army PT clinics. Most of the available metrics come from each clinic's respective MTF and do not offer a comparison to similar PT clinics or Army PT averages. Peer and individual clinic metrics such as productivity, RVUs per encounter, CPT code usage and percent of FTEs available for patient care should be distributed from an Area of Concentration (AOC) or Corps-level decision support center. Only when clinics are aware of their current performance and that of their best-performing peers, can action plans be developed to improve productivity within each clinic and consequently, across the AOC.

Coding Standardization

To accurately assess a PT clinic's productivity and make a comparison to a group of peers, each member of the peer group must use similar coding practices. There is currently wide variation in coding practices across Army PT clinics. For example, according to data queried from M2, the code 97535 (self-care management training) was recorded for 14% of the PT encounters Army-wide. However, 97535-usage varied widely from MTF to MTF, ranging from 1.5% of encounters at Walter Reed AMC to 49.2% of encounters at Martin ACH. A comprehensive PT coding guidebook was distributed to all of the PT clinics during November 2007, but oversight is required to determine if clinics follow the guidance. A combination of the coding guidebook, coding education, regular metrics updates and periodic audits should move the Army PT community towards standardized effective coding practices.

PBAM Modification

The findings of this study suggest that the current PBAM productivity benchmarking methodology may not be an effective tool for creating efficiency incentives in Army PT clinics. Specifically, the current benchmark based on aggregate historical productivity does not adequately account for technician workload or the large inpatient mission faced by AMCs. Therefore, two options exist for modifying the PBAM productivity methodology: 1) modify the calculation to include technician FTEs or 2) establish varying productivity targets based on peer groups.

Including technician FTEs seems like the most practical modification to the PBAM productivity methodology, but the current UCAPERS and DMHRSi do not differentiate between clinical and nonclinical hours for technicians. Therefore, including technician FTEs would include non-patient care time (administration, education, readiness) and grossly overestimate the number of hours actually spent providing treatment. Consequently, unless MEDCOM chooses to change how type IV providers (such as technicians) record work hours, the PBAM productivity calculations must continue to exclude technician FTEs.

Without adding tech FTEs to the PBAM productivity model, the most logical approach to modifying the PBAM is to establish productivity targets that vary according to peer groups. Peer grouping recognizes that Army PT clinics are inherently heterogeneous and consequently have variable productivity. For ease of data analysis by MEDCOM, any peer grouping must be simple. The simplest method of splitting the MTFs into peer groups is to create an AMC peer group and a non-AMC peer group. AMCs would have a lower productivity target based on their inpatient mission. Conversely, ACHs and AHCs would have a productivity target higher than the current 17.10 RVUs / FTE / Day for FY 2008.

One possible method of setting the peer group benchmarks is to adjust productivity targets based on the fixed characteristic of relative inpatient missions as defined by the proportion of inpatient-related RVUs. During FYs 2006 and 2007, the average AMC generated 13% of total clinic RVUs from inpatient care. Based on the regression equation, this inpatient care should result in a productivity decrement of roughly 4 RVUs / FTE / Day. Therefore, the AMC benchmark should be approximately 4 RVUs / FTE / Day less than the non-AMC benchmark. Considering that AMCs accounted for 41.54% of the total Army PT workload in FY 2007, setting the AMC target at 14.76 and the non-AMC target at 18.76 will recognize clinic heterogeneity but maintain the current FY 08 aggregate target of 17.10 as shown in Table 15.

TABLE 15

Calculation of peer group PBAM productivity benchmarks based on FY 2007 M2 data.

Peer Group	RVUs	% of Total RVUs	Aggregate Productivity	Proposed Benchmark
AMCs	329,196	41.54	15.18	14.76
Non-AMCs	463,342	58.46	23.89	18.76

Note. (14.76 x 41.54%) + (18.76 x 58.46%) = 17.10 RVUs / FTE / day (Current PBAM benchmark)

Certainly there are other means of creating peer group benchmarks, but the suggested simple method is the most plausible. The historical workload basis of the current PBAM is maintained while discounting the AMC productivity target based on the fixed inpatient mission. To discount the AMC productivity further could inappropriately discourage them from improving general clinic efficiency and coding optimization. However, not recognizing their inpatient mission, as is currently the case, sets the bar so high that some AMC PT clinics may face an unreachable goal. Therefore, the PBAM productivity target may not act as an incentive to encourage increased efficiency and productivity. Adopting an AMC peer group is a seemingly simple change that will perhaps offer more realistic productivity targets and allow the PBAM to better leverage improved performance.

Further Research

The completion of this study suggests the need for additional future research in various areas. First, best business practices must be identified and proliferated across Army PT clinics. Second, because coding plays such a large role in productivity, a potentially useful study would identify how to optimize coding. Third, other clinics such as occupational therapy, nutrition care and optometry could benefit from a similar review of PBAM productivity. Fourth, identification of additional predictors of PBAM productivity would help PT and other clinics to better understand and optimize productivity. Finally, this study should be repeated in the future.

Best Practice Identification and Proliferation

This study used group statistics to identify productivity variation and the predictors thereof. However, future efforts must concentrate on identifying individual top-performing clinics. Any best business practices from these clinics should be clearly documented and then proliferated to other PT clinics. Conversely, poorly performing clinics should be identified and given the assistance necessary to improve productivity.

Code Usage vs. RVUs / Encounter

Coding optimization defined as RVUs / encounter is a significant predictor of productivity. Medical centers code significantly fewer RVUs per encounter than their ACH and AHC counterparts. If AMCs truly have higher acuity patients, why do they code fewer RVUs per visit? Additional research is necessary to examine CPT code usage across Army PT clinics in order to identify underuse, overuse or misuse of codes. This research could eventually lead to benchmarks or expected ranges of code usage that align with the previously released PT coding guidelines.

Application of Methodology to Other Areas Of Concentration

This study focused specifically on Army PT clinics, but other clinics that have workload-producing technicians could also benefit from the methodology in this study. Occupational therapy (OT) services are quite similar to physical therapy and would definitely benefit from the study of OT clinic PBAM productivity. Additionally, clinics such as nutrition care and optometry that have RVU-generating techs would potentially benefit from examining productivity variation, identifying predictors, and adopting productivity-optimizing business practices.

Future Repeat of Study

This study should be repeated on an annual basis to quantify improvements in PT business practices. Ideally, one would expect to see an increase in aggregate productivity and a decrease in productivity variation. Improved productivity should result from the efficient employment of technicians, accurate reporting of non-clinical hours, optimal coding of work performed and the general proliferation of best business practices. Additionally, repeating the study in the future will validate the findings of this study looking at FY 2006 and 2007 data.

Identify Additional Productivity Predictors

This study identified four predictor variables that account for 42% of the variation in PBAM productivity, but what is responsible for the other 58%? Much of this variability is likely due to clinic specific business practices that cannot be quantified. However, further research to identify additional significant predictors of PBAM productivity would be valuable to increase understanding of productivity. Army PT clinics will never be optimally efficient until they comprehensively understand the drivers of productivity.

Appendix A: Commonly used physical therapy CPT codes and associated work RVU value

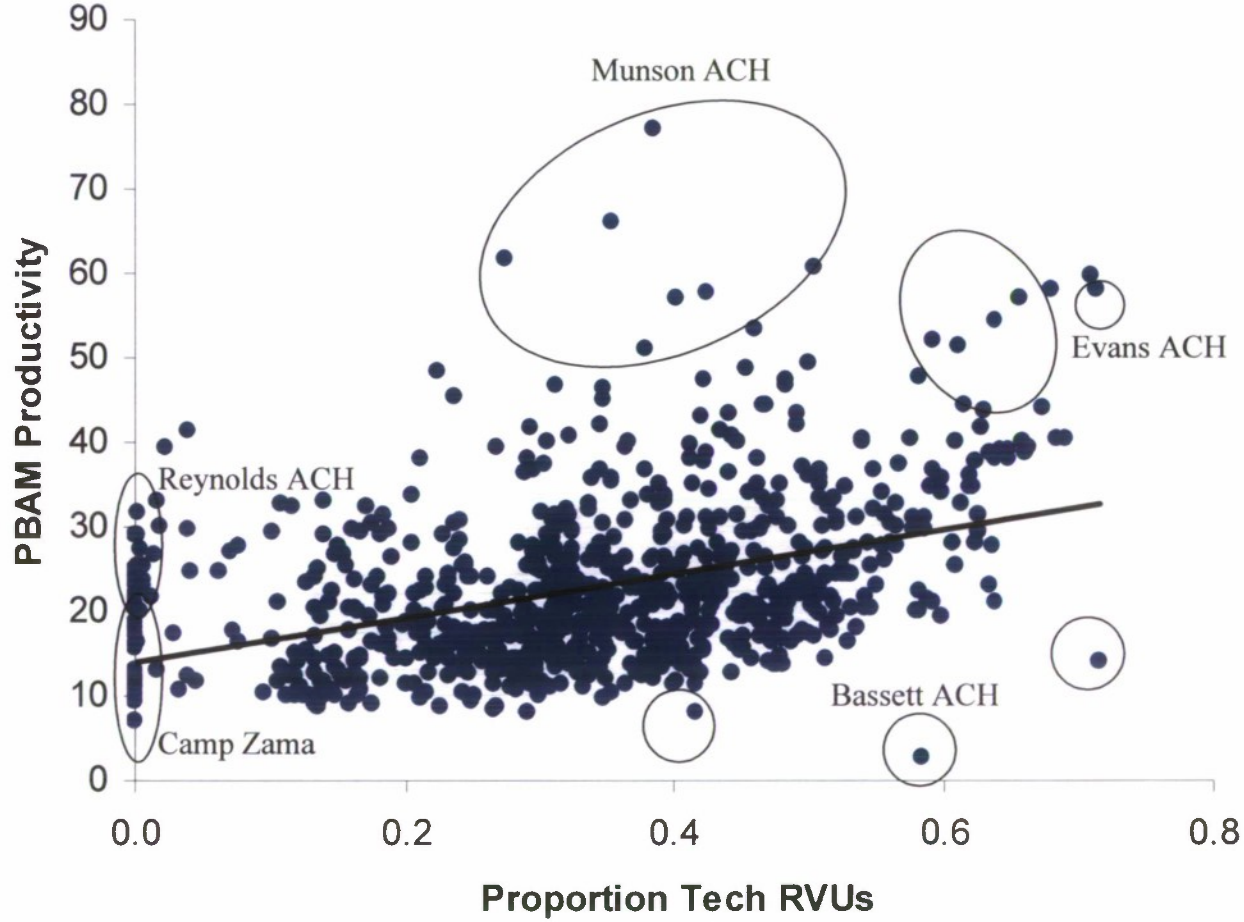
CPT Code	Short Description	Work RVUs
90901	Biofeedback	.41
95851	ROM evaluation	.16
95831	Strength evaluation	.28
97001	PT evaluation	1.20
97002	PT re-evaluation	.60
97006	Hot pack / ice pack	.06
97012	Mechanical traction therapy	.25
97014	Electrical stimulation, unattended	.18
97016	Vasopneumatic device therapy	.18
97018	Paraffin bath therapy	.06
97022	Whirlpool therapy	.17
97032	Electric stimulation, attended	.25
97033	Iontophoresis	.26
97034	Contrast bath therapy	.21
97035	Ultrasound therapy	.21
97036	Hydrotherapy	.28
97110	Therapeutic exercises	.45
97112	Neuromuscular reeducation	.45
97113	Aquatic therapy / exercises	.44
97116	Gait training therapy	.40
97124	Massage therapy	.35
97140	Manual therapy	.43
97150	Group therapeutic procedures	.27
97530	Therapeutic activities	.44
97535	Self care management training	.45
97542	Wheelchair management training	.45
97597	Active wound care / 20cm or <	.58
97598	Active wound care > 20cm	.80
97750	Physical performance test	.45
97760	Orthotic management and training	.45
97761	Prosthetic training	.45
97762	Prosthetic check out	.25
98925	Osteopathic technique 1-2 segments	.45
98926	Osteopathic technique 3-4 segments	.65

Note: Adapted from Centers for Medicare & Medicaid Services
Retrieved January 15, 2008 from http://www.cms.hhs.gov/pfslookup/

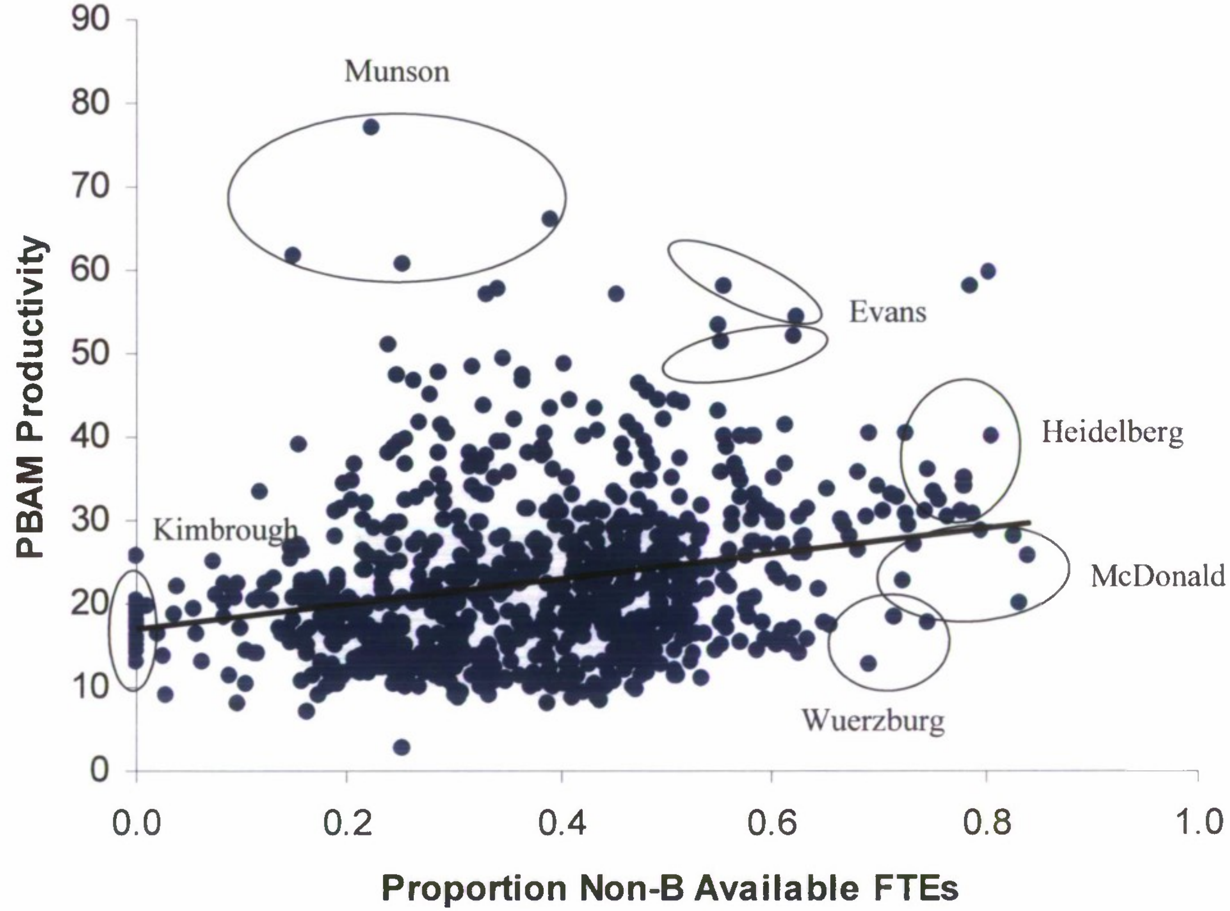
Appendix B. MTF name and associated fort, city and state / country by hospital size

Facility	Fort Name	Nearest City	State / Country
AMCs:			
Landstuhl RMC	Landstuhl	Landstuhl	Germany
Brooke AMC	Fort Sam Houston	San Antonio	Texas
Darnall AMC	Fort Hood	Killeen	Texas
William Beaumont AMC	Fort Bliss	El Paso	Texas
Walter Reed AMC	NA	Washington, DC	District of Columbia
Womack AMC	Fort Bragg	Fayetteville	North Carolina
Tripler AMC	Fort Shafter	Honolulu	Hawaii
Eisenhower AMC	Fort Gordon	Augusta	Georgia
Madigan AMC	Fort Lewis	Tacoma	Washington
ACHs:			
121st General Hospital	Camp Kasey	Seoul	Korea
Heidelberg MEDDAC	Heidelberg	Heidelberg	Germany
Wuerzburg MEDDAC	Wuerzburg	Wuerzburg	Germany
Baynes-Jones ACH	Fort Polk	Leesville	Louisiana
Evans ACH	Fort Carson	Colorado Springs	Colorado
Irwin ACH	Fort Riley	Manhattan	Kansas
Leonard Wood ACH	Fort Leonard Wood	Waynesville	Missouri
Reynolds ACH	Fort Sill	Lawton	Oklahoma
Dewitt ACH	Fort Belvoir	Fort Belvoir	Virginia
Ireland ACH	Fort Knox	Radcliff	Kentucky
Keller ACH	US Military Academy	West Point	New York
Blanchfield ACH	Fort Campbell	Clarksville	Tennessee
Martin ACH	Fort Benning	Columbus	Georgia
Moncrief ACH	Fort Jackson	Columbia	South Carolina
Winn ACH	Fort Stewart	Hinesville	Georgia
Bassett ACH	Fort Wainwright	Fairbanks	Alaska
Weed ACH	Fort Irwin	Barstow	California
AHCs:			
Munson AHC	Fort Leavenworth	Leavenworth	Kansas
RW Bliss AHC	Fort Huachuca	Sierra Vista	Arizona
Guthrie AHC	Fort Drum	Watertown	New York
Kenner AHC	Fort Lee	Petersburg	Virginia
Kimbrough ACC	Fort Meade	Odenton	Maryland
McDonald AHC	Fort Eustis	Newport News	Virginia
BG Crawford Sams AHC	Camp Zama	Tokyo	Japan
Lyster AHC	Fort Rucker	Enterprise	Alabama

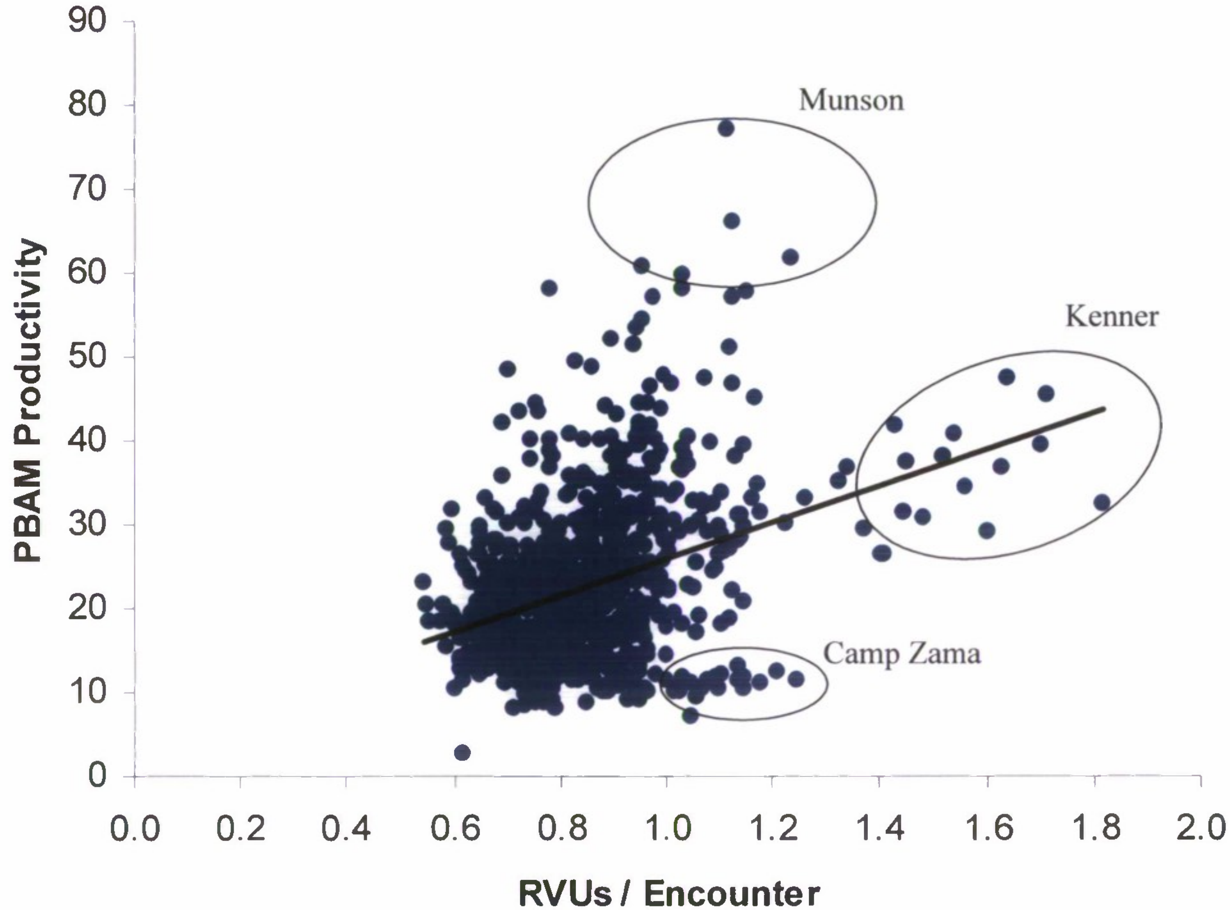
Appendix C. Scatter plot relating monthly averages of proportion of tech RVUs and PBAM productivity



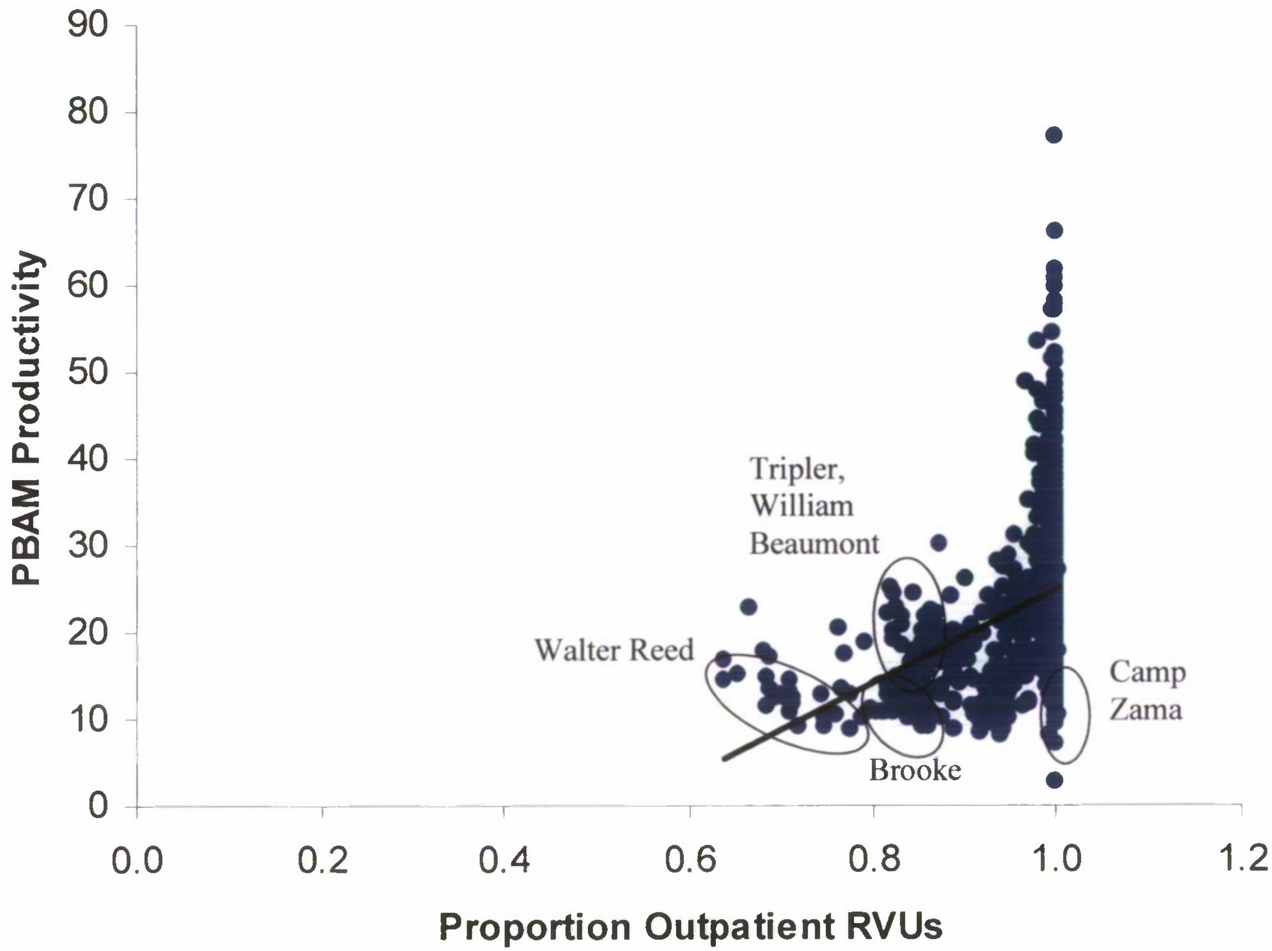
Appendix D. Scatter plot relating monthly averages of the proportion of non-B available FTEs and PBAM productivity



Appendix E. Scatter plot relating monthly averages of RVUs / encounter and PBAM productivity



Appendix F. Scatter plot relating monthly averages of the proportion of outpatient RVUs and PBAM productivity



Appendix G. Factors used when constructing control charts

Number of Observations in Sample (n)	**Mean Chart Factor for Control Limits A_2**	**Range Chart Factor for Control Limits D_3**	**Range Chart Factor for Control Limits D_4**
2	1.880	0	3.276
3	1.023	0	2.575
4	.729	0	2.282
5	.577	0	2.115
6	.483	0	2.004
7	.419	.076	1.924
8	.373	.136	1.864
9	.337	.184	1.816
10	.308	.223	1.777
11	.285	.256	1.744
12	.266	.284	1.719
13	.249	.308	1.692
14	.235	.329	1.671
15	.223	.348	1.652
16	.212	.364	1.636
17	.203	.379	1.621
18	.194	.392	1.608
19	.187	.404	1.596
20	.180	.414	1.586
21	.173	.425	1.575
22	.167	.434	1.566
23	.162	.443	1.557
24	**.157**	**.452**	**1.548**
25	.153	.459	1.541

Note. n = 24. Retrieved April 16, 2008 from:
http://www.vgtu.lt/leidiniai/elektroniniai/Probability.pdf/Table%2011.pdf

Appendix H. Predictor variable and PBAM productivity unweighted averages by individual MTF and MTF type during FYs 2006 and 2007.

Facility	Tech RVUs	Non-B FTEs	RVUs / Enc	Outpnt RVUs	Productivity
AMCs:					
Landstuhl	.27	.46	.80	.92	12.06
Brooke	.14	.38	.92	.83	10.76
Darnall	.27	.49	.71	.99	16.94
W Beaumont	.43	.37	.64	.86	15.63
Walter Reed	.13	.25	.82	.71	12.89
Womack	.52	.36	.71	.96	20.91
Tripler	.45	.39	.77	.84	18.02
Eisenhower	.31	.27	.81	.90	20.81
Madigan	.34	.48	.70	.87	18.72
Average:	**.32**	**.38**	**.76**	**.87**	**16.30**
ACHs:					
121st GH	.37	.50	.90	.98	32.76
Heidelberg	.48	.70	.87	1.00	30.27
Wuerzburg	.32	.57	.75	1.00	15.31
Baynes-Jones	.41	.29	.65	1.00	23.20
Evans	.61	.40	.92	1.00	40.29
Irwin	.34	.46	.80	.99	25.24
L Wood	.39	.34	.91	.98	29.52
Reynolds	.12	.40	.73	.99	23.75
Dewitt	.17	.37	.86	1.00	24.70
Ireland	.29	.38	.74	1.00	18.57
Keller	.25	.35	.74	.94	12.29
Blanchfield	.59	.45	.95	.99	33.59
Martin	.25	.32	.93	.99	20.38
Moncrief	.30	.30	1.04	.99	25.34
Winn	.35	.51	.84	.99	21.82
Bassett	.44	.28	.79	1.00	17.47
Weed	.43	.27	.87	1.00	17.65
Average:	**.36**	**.40**	**.84**	**.99**	**24.24**
AHCs:					
Munson	.42	.19	.94	1.00	36.20
RW Bliss	.35	.20	.80	1.00	21.79
Guthrie	.17	.46	.96	1.00	26.15
Kenner	.37	.28	1.40	1.00	33.28
Kimbrough	.21	.10	.91	1.00	19.88
McDonald	.50	.64	.95	1.00	28.02
Camp Zama	.00	.29	1.09	1.00	11.23
Lyster	.39	.38	.75	1.00	34.76
Average:	**.30**	**.32**	**.97**	**1.00**	**26.41**

Appendix I. Acronym and definition list

ACH	Army Community Hospital (small Army hospital with inpatient services)
ADM	Ambulatory Data Module (collects patient diagnoses and procedures)
AHC	Army Health Clinic (small Army hospital without inpatient services)
AHLTA	Armed Forces Health Longitudinal Technology Application (Army MTF electronic health record application)
AMA	American Medical Association (professional association of physicians)
AMC	Army Medical Center (large Army hospital with extensive inpatient services)
AOC	Area of Concentration (military terminology for job specialty)
APTA	American Physical Therapy Association (professional association of physical therapists)
CAPER	Comprehensive Ambulatory/Professional Encounter Record (future tool for capturing encounter data)
CHCS	Composite Health Care System (relational database used in MTFs)
CMS	Center for Medicare and Medicaid Services
CPT	Common Procedural Terminology (five digit numerical code and short description of common procedures)
DMHRSi	Defense Medical Human Resource System internet (internet-based labor hour tracking system)
DMIS ID	Defense Medical Information System Identification (unique four digit number identifying each MTF)
DoD	Department of Defense

EAS IV	Expense Assignment System (data repository including labor hours)
E & M	Evaluation and Management (five digit numerical code that varies based on encounter complexity)
FCC	Functional Cost Code (specific functions within an MTF identified by a four letter code)
FTE	Full Time Equivalent (21 days x 8 hours/day = 168 hours/month)
FY	Fiscal Year (budget year from October 1 to September 30)
HEDIS	Health Effectiveness Data and Information Set (tool for comparing health plan performance)
Histogram	a graphical display of tabulated frequencies
HP & S	Health Policy and Services (policy developing division of MEDCOM)
K-S Test	Kolomogorov-Smirnov Test (test of normal distribution)
Kurtosis	the relative peakedness of a distribution
LCL	Lower Control Limit (horizontal line drawn on a control chart at a specified distance below the central line)
MEDCOM	Medical Command
MEPRS	Medical Expense and Performance Reporting System (Army system that collects expense, manpower and workload data)
MGMA	Medical Group Management Association (professional association of medical group practices)
MHS	Military Health System (health system of the Army, Navy, Air Force, Coast Guard, and commissioned corps of the Public Health Service)

MLR	Multiple Linear Regression (statistical technique that attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data)
MTF	Military Treatment Facility (an armed services hospital or clinic)
M2	Military Health System Management and Analysis Reporting Tool (MHS data repository)
OTSG	Office of the Surgeon General
PBAM	Performance Based Adjustment Model (model that modifies MTF funding based on actual medical outcomes compared to performance objectives)
P-P Plot	Probability-Probability Plot (graphical display that tests for distribution normality)
PPS	Prospective Payment System (method of reimbursement in which payment is made based on a predetermined, fixed amount)
Productivity	outputs produced per unit of input
PT	Physical Therapy
RBRVS	Resource-based Relative Value Scale (model for determining payment to medical providers)
RMC	Regional Medical Command (one of six different geographical areas established for administrative control)
RVU	Relative Value Unit (standard factor used in pricing of medical services)
SADR	Standard Ambulatory Data Report (tool for capturing MTF encounter data)
Skewness	relative asymmetry of a distribution
SP	Army Medical Specialist Corps (Army Corps containing occupational therapists, physical therapists, dietitians and physician assistants)

SPC	Statistical Process Control (statistical techniques for identifying common cause versus special cause variation)
SPSS	Statistical Package for the Social Sciences
TMA	TRICARE Management Activity (manages the TRICARE program under the authority of the Office of the Assistant Secretary of Defense for Health Affairs)
Type I Error	rejecting the null hypothesis when it is true
Type II Error	accepting the null hypothesis when it is false
UCAPERS	Uniform Chart of Accounts and Personnel Utilization System (standard automated Army system that collects and reports personnel hours)
UCL	Upper Control Limit (horizontal line drawn on a control chart at a specified distance above the central line)
USAF	United States Air Force
Z-score	standard score indicating how many standard deviations an observation is above or below the mean

References

Abdi, H. (2003). Partial regression coefficients. In M. Lewis-Beck, A. Bryman & T. Futing (Eds.), *Encyclopedia of Social Sciences Research Methods*. Thousand Oaks, CA: Sage.

American Medical Association. (September 22, 2006). Overview of RBRVS. Retrieved December 6, 2007 from http://www.ama-assn.org/ama/pub/category/print/16392.html

American Physical Therapy Association. (2007). Does APTA have guidelines for determining appropriate productivity standards or staffing levels? Retrieved December 18, 2007 from http://www.apta.org/AM/Template.cfm?Section=Home&Template=/MembersOnly.cfm&ContentID=38114

Archila, A. M., Jarecke, A. J., Damiani, T. N., & Boorady, J. (2007). Tri-service optometry productivity findings and benchmark recommendation. *Military Medicine*, 172(4), 418-420.

Bacharach, S. B. (1989). Organizational theories: Some criteria for evaluation. *Academy of Management Review, 14*, 490-495.

Basu, S. (2008, February 25). TRICARE fees would rise under DoD's proposed FY '09 budget. *U.S. Medicine Information Central.* Retrieved April 21, 2008 from http://www.usmedicine.com/dailyNews.cfm?dailyID=370

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences (2nd Ed.).* Hillsdale, NJ:Lawrence Erlbaum Associates, Inc.

Cooper, D. R., & Schindler, P. S. (2003). *Business Research Methods (8^{th} ed.).* New York: McGraw-Hill.

Coppola, M. N. (2003). *Correlates of Military Medical Treatment Facility (MTF) Performance: Measuring Technical Efficiency with the Structural Adaptation to Regain Fit (SARFIT) Model and Data Envelopment Analysis (DEA).* Unpublished doctoral dissertation, Virginia Commonwealth University.

Coppola, M. N., Harrison, J., Kerr, B., & Erckenbrack, D. (2007) The Military Managed Care Health System. In P. R. Kongstevdt (Ed.), *Essentials of Managed Care, (5th ed.).* Gaithersburg, MD: Aspen Publishers.

Donabedian, A. (1988). The quality of care: How can it be assessed? *Journal of the American Medical Association*, 260(12), 1743-1748.

Donaldson, L. (2001). *The Contingency Theory of Organizations*. Thousand Oaks, California: Sage Publications.

Fogel, P. (2000). Achieving Superior Productivity. *Healthcare Financial Management*, 54(8), 50-54.

Glass, K. P., & Anderson, J. R. (2002a). Relative value units: From A to Z (Part I of IV). *Journal of Medical Practice Management*, 17(5), 225-228.

Glass, K. P., & Anderson, J. R. (2002b). Relative value units and productivity (Part 2 of 4). *Journal of Medical Practice Management*, 17(6), 285-290.

Glass, K. P., & Anderson, J. R. (2002c). Relative value units and cost analysis. (Part 3 of 4). *Journal of Medical Practice Management*, 18(2), 66-70.

Glass, K. P., & Piland, N. F. (2002d). Relative value units: From A to Z. (Part 4 of 4). *Journal of Medical Practice Management*, 18(3), 120-123.

Hsiao, W. C., Braun, P., Edmund B. R., & Thomas, S. R. (1987). The Resource-based Relative Value Scale: toward the development of an alternative physician payment system. *Journal of The American Medical Association*, 258(6), 799-802.

Hsiao, W. C., Braun, P., Dunn, D., & Edmund B. R. (1988). Resource-based relative values: An overview. *Journal of the American Medical Association*, 260(16), 2347-2353.

Johnson, S. E. & Warren, P. N. (2002). Resource-based relative value units: A primer for Academic family physicians. *Family Medicine*, 34(3), 172-176.

MEPRS Application and Data Improvement Workshop. (2007). San Antonio, TX.

Military Health System Help Desk. Ambulatory Data Module. Retrieved 28 May, 2007 from http://www.mhs-helpdesk.com/Pages/chcs_adm.asp

Mongan, P. D., Van Der Schuur, B., Damiano, L. A., & Via, D. K. (2003). Developing meaningful metrics of clinical productivity for military treatment facility anesthesiology departments and operative services. *Military Medicine*, 168(11), 880-884.

Ozcan, Y. A. (2005). *Quantitative Methods in Health Care Management: Techniques and Applications*. San Francisco, CA: Jossey-Bass.

Opsut, B. (2007). Health Affairs Lecture at U.S. Army-Baylor Program in Health and Business Administration.

Performance Based Adjustment Model Handbook. (April 2007).

Ransom, B. S., Maulik, S. J., & Nash, B. N. (2004). *The Healthcare Quality Book: Vision, Strategy and Tools*. Chicago, IL: Health Administration Press.

Sanders, D. H., & Smidt, R. K. (2000) *Statistics: A First Course (6th ed.)*. New York: McGraw-Hill.

Schoomaker, E. (2008). Army medicine strategic planning guidance. Headquarters, United States Army Medical Command.

Tosi, H. L. & Slocum, J. W. (1984). Contingency theory: Some suggested directions. *Journal of Management*, 10(1), 9-2.